ANALYST'S LABORATORY COMPANION

ALFRED E. JOHNSON

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THE ANALYST'S LABORATORY COMPANION:

A COLLECTION OF TABLES AND DATA FOR THE USE OF PUBLIC AND GENERAL ANALYSTS, AGRICULTURAL, BREWERS' AND WORKS' CHEMISTS, AND STUDENTS

BY

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SECOND EDITION, ENLARGED AND IMPROVED

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PREFACE TO SECOND EDITION.

In this Edition numerous additions and improvements have been made, of which the following are the chief:—

The list of multipliers required in gravimetric analysis has been largely extended and entirely re-cast. Five-figure logarithms have, after consideration, been adopted in place of the seven-figure logarithms given in the first edition, as they have been found to be quite sufficient for all practical purposes. As an improvement in detail it may be pointed out that, to facilitate reference, the factors have now been printed in sets of two or three, instead of *en bloc.* My thanks are due to Mr E. W. T. Jones, F.I.C., for kindly supplying several of the new factors given.

Instead of the table of seven-figure logarithms of numbers 1 to 1000 only, a table of five-figure logarithms is given, by means of which percentages can readily be obtained correctly to two decimal places. This will probably be considered one of the most important improvements in the book. The table given is taken, by kind permission of the authors, from Geipel & Kilgour's *Pocket Book of Electrical Engineering Formulæ;* the stereotype plates were supplied by the *Electrician* Publishing Company.

The section devoted to weights and measures has been entirely re-written, the new values adopted being those given in H. J. Chaney's standard work on *Our Weights and Measures* (1897).

The pages dealing with the specific rotatory and cupric reducing powers of the carbohydrates have also been entirely re-written and much extended. The papers by O'Sullivan & Stern (1896), and especially the valuable series by Brown, Morris, and Millar (1897), all published in the *Jour. Chem. Soc.*, have been freely drawn upon in the compilation of this part of the book.

The table for conversion of nitrogen into albuminoids has been re-calculated, using the modern factor 6·25 in place of the ancient 6·33.

The new table for the Kjeldahl process will be found a time-saver by all who use that beautiful method of determining nitrogen.

The Baumé's hydrometer table 'for liquids heavier than water' has been replaced by an abridged form of the very complete table given in Lunge & Hurter's *Alkali Makers' Handbook*.

At p. 80A will be found two simple and useful rules for obtaining the degree of dilution in the case of watered spirits; and at p. 80B an exceedingly useful table for correcting the sp. gr. of dilute alcohol for temperature.

This latter table—by J. F. Liverseege—has just appeared in the *Analyst* (June, 1897), and it has fortunately been found possible to insert it, with an additional column giving the correction for 1° C.

The sp. gr. tables, pp. 81–84, remain as in the first edition. If anything further than these is required, the exhaustive tables given in Lunge & Hurter's *Alkali Makers' Handbook* should be consulted.

The tables for butter analysis are new. The milk table on p. 93 is taken from Dr Muter's *Manual of Analytical Chemistry*.

The "table of reciprocals" (p. 94) will be found of great value in numerous calculations, as by it division becomes converted into simple multiplication.

The glycerine table is new.

The table on p. 96 will be of service in all exact volumetric work.

In addition to the above, the whole book has been very carefully revised throughout, and several other additions and improvements in detail have been made, which will, no doubt, be appreciated by those who use the book regularly.

I trust, therefore, that this Second Edition may be found distinctly more useful to chemical workers than its predecessor.

A. E. JOHNSON.

155 Lea Road,
Wolverhampton, *August*, 1897.

CONTENTS.

THE
ANALYST'S LABORATORY COMPANION.

SYMBOLS AND ATOMIC WEIGHTS OF THE ELEMENTS AS USED IN THIS WORK.

Names of Elements.	Symbols.	Atomic Weights.	Names of Elements.	Symbols.	Atomic Weights.
Aluminium, .	Al	27	Mercury, . .	Hg	200
Antimony, .	Sb	120	Molybdenum, .	Mo	95·8
Arsenic, . .	As	75	Nickel, . .	Ni	58·6
Barium, . .	Ba	137	Niobium, .	Nb	94
Beryllium, .	Be	9·1	Nitrogen, .	N	14
Bismuth, . .	Bi	208	Osmium, . .	Os	193
Boron, . .	B	11	Oxygen, . .	O	16
Bromine, . .	Br	80	Palladium, .	Pd	106·2
Cadmium, .	Cd	112	Phosphorus, .	P	31
Cæsium, . .	Cs	132·7	Platinum, .	Pt	197·2*
Calcium, . .	Ca	40	Potassium, .	K	39
Carbon, . .	C	12	Rhodium, .	Rh	104
Cerium, . .	Ce	139·9	Rubidium, .	Rb	85·2
Chlorine, .	Cl	35·5	Ruthenium, .	Ru	104·4
Chromium, .	Cr	52·5	Selenium, .	Se	78·8
Cobalt, . .	Co	59	Silicon, . .	Si	28·3
Copper, . .	Cu	63·2	Silver, . .	Ag	107·7
Didymium, .	Di	144	Sodium, . .	Na	23
Erbium, . .	E	166	Strontium, .	Sr	87·3
Fluorine, .	F	19	Sulphur, . .	S	32
Gallium, . .	Ga	69	Tantalum, .	Ta	182
Gold, . .	Au	196·8	Tellurium, .	Te	125
Hydrogen, .	H	1	Thallium, .	Tl	203·7
Indium, . .	In	113·4	Thorium, .	Th	231·9
Iodine, . .	I	126·5	Tin, . .	Sn	118
Iridium, . .	Ir	192·5	Titanium, .	Ti	48
Iron, . .	Fe	56	Tungsten, .	W	183·6
Lanthanum, .	La	138	Uranium, .	U	240
Lead, . .	Pb	206·5	Vanadium, .	V	51·2
Lithium, .	Li	7	Yttrium, . .	Y	89·6
Magnesium, .	Mg	24	Zinc, . .	Zn	65
Manganese, .	Mn	55	Zirconium, .	Zr	90

* The true atomic weight of platinum appears to be 194·3. The value Pt=197·2 is, however, the one adopted by all the German potash makers, because it gives the most accurate results in analysis: hence it is used in this book. See note on p. 19.

Notes on Indicators.

I. **Litmus solution.**—A solution of a carbonate whilst being titrated should be boiled to expel the free CO_2, otherwise it is easy to overstep the exact point of neutrality. The titration cannot be done by gas-light.

According to R. Reinitzer (see Abstract *Analyst*, 1894, p. 255) litmus is the most serviceable indicator when properly prepared. Good litmus should be taken, and the aqueous solution, which contains alkaline carbonate, boiled for seven or eight minutes and then neutralized with HCl, so that the wine-red colour remains even on further boiling. The solution is then cooled, and an equal volume of strong alcohol added. The stock solution should be kept in a bottle with a delivery pipette inserted through the cork. The final change of colour is sharpest when the liquid to be titrated is boiled for seven or eight minutes and then well cooled.

II. **Methyl orange** (para-dimethylaniline-azo-benzone-sulphonic acid).

Solution.—One gram in a litre of distilled water.

Unlike litmus, this indicator is unaffected by CO_2, SH_2, boric, arsenious, hydrocyanic, and carbolic acids, &c. It must not be used for organic acids; nor in the presence of nitrous acid or nitrites, which decompose it. It acts admirably with mineral acids and with ammonia and its salts. Ordinary temperatures should be observed.

Colour reaction.—Faint yellow if alkaline, pink if acid.

III.—**Phenol-phthalein** ($C_{20}H_{14}O_4$).

Solution.—Dissolve 4 grams* in half a litre of strong alcohol, then add gradually with constant stirring an equal volume of distilled water.

It is useless for the titration of free ammonia or its compounds, or for the fixed alkalies when salts of ammonia are present. Unlike methyl orange, it is specially useful in titrating all varieties of organic acids—viz., oxalic, acetic, citric, tartaric, &c. It may be used either in alcoholic solutions or in mixtures of alcohol and ether.

Colour reaction.—Colourless in neutral or acid liquids, but rendered purple-red by faint excess of caustic alkali.

IV.—**Cochineal solution.**

Solution.—Digest one part of powdered cochineal with 10 parts of 25 per cent. alcohol.

It is not very much modified in colour by CO_2, and may be used by gas-light. Most useful in titrating solutions of the alkaline earths, such as lime and baryta-water. Inapplicable in the presence of even traces of Fe or Al compounds or acetates.

Colour reaction.—Turned violet by alkalies; the original yellowish-red colour being restored by mineral acids.

V.—**Phenacetolin.**

Solution.—Two grams in a litre of alcohol.

* F. Sutton (*Volumetric Analysis*) recommends a stronger solution, viz., 10 grams instead of 4.

This indicator may be used to estimate the amount of KHO or NaHO in the presence of K_2CO_3 or Na_2CO_3, or of CaO in the presence of $CaCO_3$.

Colour reaction—

With NH_3 and normal alkaline carbonates—dark pink.
„ bicarbonates —intense pink.
„ mineral acids —golden yellow.

VI.—**Rosolic Acid** ($C_{20}H_{16}O_3$).

Solution.—Two grams in a litre of 50 per cent. alcohol.

This indicator is excellent for all the mineral, but useless for the organic acids, except oxalic. It may be relied on for the neutralization of SO_2 with ammonia to normal sulphite.

Colour reaction.—The pale yellow colour is unaffected by acids, but changed to violet-red by alkalies.

THE PRECIPITATING POWERS OF A FEW COMMON REAGENTS.

1. Ammonic oxalate. $(NH_4)_2C_2O_4, OH_2$.
40 grams per litre.
For 1 gram taken
10 c.c. will precipitate 15·78 per cent. CaO.
„ „ 28·17 „ $CaCO_3$.
„ „ 38·31 „ $CaSO_4$.
„ „ 29·11 „ $Ca_3P_2O_8$.

2. Baric chloride. $BaCl_2, 2OH_2$.
100 grams per litre.
For 1 gram taken
10 c.c. will precipitate 13·11 per cent. S.
„ „ 32·79 „ SO_3.
„ „ 40·16 „ H_2SO_4.
„ „ 55·74 „ $CaSO_4$.

3. Hydric disodic phosphate. $Na_2HPO_4, 12OH_2$.
100 grams per litre.
For 1 gram taken
10 c.c. will precipitate 11·17 per cent. MgO.
„ „ 23·46 „ $MgCO_3$.
„ „ 33·51 „ $MgSO_4$.

4. Prepared magnesia solution.
Dissolve 40 grams of "Magnesia" in HCl, and add a solution of 150 grams of NH_4Cl in the least possible quantity of water. Add 0·960 NH_4HO till a slight precipitate forms, and filter. Make the clear filtrate up to 1500 c.c. with distilled water, and add 750 c.c. 0·960 NH_4HO. Allow the liquid to stand and filter for use.
The strength of this solution is usually such that for 1 gram taken
10 c.c. will precipitate 30 per cent. $Ca_3P_2O_8$.

FORMULÆ, MOLECULAR WEIGHTS, AND PERCENTAGE COMPOSITIONS OF COMMONLY OCCURRING COMPOUNDS.

Name.	Formula.	Molecular Weight.	Percentage Composition.
ALUMINIUM (Al=27)			
Aluminic chloride,	Al_2Cl_6	267	Al 20·22 ; Cl 79·78
,, hydrate,	$Al_2H_6O_6$	156	Al_2O_3 65·38 ; H_2O 34·62
,, oxide,	Al_2O_3	102	Al 52·94 ; O 47·06
,, sulphate,	$Al_2(SO_4)_3$, $18OH_2$	342+324=666	Al_2O_3 15·32 ; SO_3 36·03 ; OH_2 48·65
Alum (ammonia),	$Al_2(SO_4)_3$, $(NH_4)_2SO_4$, $24OH_2$	474+432=906	Al_2O_3 11·26 ; NH_3 3·75 ; SO_3 35·32 ; OH_2 47·67
,, (potash),	$Al_2(SO_4)_3$, K_2SO_4, $24OH_2$	566+432=948	Al_2O_3 10·76 ; K_2O 9·91 ; SO_3 33·76 ; OH_2 45·57.
AMMONIUM (NH_4=18)			
Ammonia,	NH_3	17	H 17·65 ; N 82·35
Ammonic hydrate,	NH_4OH	35	NH_3 48·57 ; OH_2 51·43
,, bromide,	NH_4Br	98	NH_3 17·34 ; HBr 82·66
,, chloride,	NH_4Cl	53·5	NH_3 31·78 ; HCl 68·22
,, carbonate,	$(NH_4)_2CO_3 . OH_2$	96+18	
,, bichromate,	$(NH_4)_2Cr_2O_7$	252	
,, molybdate,	$(NH_4)_6Mo_7O_{24}$, $4OH_2$	1232·5	
,, nitrate,	NH_4NO_3	80	NH_3 21·25 ; HNO_3 78·75
,, oxalate,	$(NH_4)_2C_2O_4$, OH_2	124+18=142	(anhydr.) NH_3 27·42 ; $H_2C_2O_4$ 72·58
,, sesquicarbonate,	$2(NH_4)_2O . 3CO_2$	236	NH_3 28·81 ; CO_2 55·93 ; OH_2 15·26
,, sulphate,	$(NH_4)_2SO_4$	132	NH_3 25·76 ; H_2SO_4 74·24
,, sodic hydric phosphate,	$NH_4NaHPO_44OH_2$	137+72=209	
,, hydric sulphide,	NH_4HS	51	
,, sulphocyanate,	NH_4CNS	76	NH_3 22·37 ; H 1·31 ; CN 34·21 ; S 42·11

ANTIMONY (Sb=120)			
Antimonious chloride, . .	$SbCl_3$	226·5	Sb 52·98 ; Cl 47·02
Antimonic ,, . .	$SbCl_5$	297·5	
Antimonious oxide, . . .	Sb_2O_3	288	Sb 83·33 ; O 16·67
Antimonic anhydride, . .	Sb_2O_5	320	
Diantimonic tetroxide, . .	Sb_2O_4	304	Sb 78·95 ; O 21·05
Antimonious sulphide, . .	Sb_2S_3	336	Sb 71·43 ; S 28·57
Antimonic ,, . .	Sb_2S_5	400	Sb 60·00 ; S 40·00
Antimonious potassic tartrate (Tartar-emetic), . . .	$2C_4H_4K(SbO)O_6, OH_2$	664	
ARSENIC (As=75)			
Arsenious chloride, . . .	$AsCl_3$	181·5	As 41·32 ; Cl 58·68
,, oxide, . . .	As_2O_3	198	As 75·76 ; O 24·24
Arsenic ,, . . .	As_2O_5	230	As 65·22 ; O 34·78
Arsenious sulphide, . . .	As_2S_3	246	As 60·98 ; S 39·02
Arsenic ,, . . .	As_2S_5	310	As 48·39 ; S 51·61
Ammonic magnesic arsenate, .	$NH_4MgAsO_4, 6OH_2$	289	
BARIUM (Ba=137)			
Baric carbonate, . . .	$BaCO_3$	197	BaO 77·67 ; CO_2 22·33
,, chloride, ...	$BaCl_2, 2OH_2$	208+36=244	(anhydrous) Ba 65·86 ; Cl 34·14 (cryst.) $BaCl_2$ 85·25 ; OH_2 14·75
,, nitrate, ...	$Ba2NO_3$	261	BaO 58·62 ; N_2O_5 41·38
,, oxide, ...	BaO	153	Ba 89·54 ; O 10·46
,, peroxide, ...	BaO_2	169	
,, sulphate, ...	$BaSO_4$	233	BaO 65·66 ; SO_3 34·34
,, sulphide, ...	BaS	169	
BISMUTH (Bi=207·5)			
Bismuthous chloride, . .	$BiCl_3$	314	
,, oxide, . . .	Bi_2O_3	463	Bi 89·63 ; O 10·37

FORMULÆ, MOLECULAR WEIGHTS, AND PERCENTAGE COMPOSITIONS OF COMMONLY OCCURRING COMPOUNDS—*continued.*

Name.	Formula.	Molecular Weight.	Percentage Composition.
Bismuthous nitrate,	$Bi(NO_3)_3$, $5OH_2$	393·5+90=483·5	
,, sulphide,	Bi_2S_3	511	
BORON (B=11)			
Boric anhydride,	B_2O_3	70	B 31·43 ; O 68·57
,, acid,	H_3BO_3	62	B_2O_3 56·45 ; OH_2 43·55
CADMIUM (Cd=112)			
Cadmic chloride,	$CdCl_2$, $2OH_2$	183+36=219	
,, carbonate,	$CdCO_3$	172	
,, oxide,	CdO	128	Cd 87·50 ; O 12·50
,, sulphide,	CdS	144	Cd 77·78 ; S 22·22
CALCIUM (Ca=40)			
Calcic chloride,	$CaCl_2$, $6OH_2$	111+108=219	(anhydr.) Ca 36·03 ; Cl 63·97
,, fluoride,	CaF_2	78	Ca 51·28 ; F 48·72
,, oxide,	CaO	56	Ca 71·43 ; O 28·57
,, carbonate,	$CaCO_3$	100	CaO 56 ; CO_2 44
,, hydrate,	CaH_2O_2	74	CaO 75·68 ; OH_2 24·32
,, sulphide,	CaS	72	Ca 55·56 ; S 44·44
,, sulphate,	$CaSO_4$	136	CaO 41·18 ; SO_3 58·82
,, ,, (crystal),	$CaSO_4$, $2OH_2$	172	$CaSO_4$ 79·07 ; OH_2 20·93
,, nitrate,	$Ca(NO_3)_2$, $4OH_2$	164+72=236	
Tricalcic phosphate,	$Ca_3P_2O_8$	310	CaO 54·19 ; P_2O_5 45·81
CARBON (C=12)			
Carbonic oxide,	CO	28	C 42·86 ; O 57·14

Carbonic anhydride, . . .	CO_2	44	C 27·27 ; O 72·73
CHROMIUM (Cr=52·5)			
Chromic chloride, . . .	Cr_2Cl_6	318	
,, oxide, ...	Cr_2O_3	153	Cr 68·63 ; O 31·37
,, sulphate, . . .	$Cr_2(SO_4)_3$	393	
COBALT (Co=59)			
Cobaltous chloride, . . .	$CoCl_2$	130	
,, oxide, . . .	CoO	75	Co 78·67 ; O 21·33
,, nitrate, . . .	$Co(NO_3)_2$, $6OH_2$	183+108=291	
COPPER (Cu=63·2)			
Cuprous chloride, . . .	Cu_2Cl_2	197·4	Cu 64·03 ; Cl 35·97
,, oxide, ...	Cu_2O	142·4	Cu 88·76 ; O 11·24
,, sulphide, . . .	Cu_2S	158·4	Cu 79·80 ; S 20·20
Cupric chloride, . . .	$CuCl_2$	134·2	Cu 47·09 ; Cl 52·91
,, oxide, ...	CuO	79·2	Cu 79·80 ; O 20·20
,, sulphide, . . .	CuS	95·2	Cu 66·39 ; S 33·61
,, sulphate, . . .	$CuSO_4$, $5OH_2$	159·2+90=249·2	(crystals) CuO 31·84 ; SO_3 32·07 ; OH_2 36·09
,, nitrate, ...	$Cu(NO_3)_2$, $6OH_2$	187·2+108=295·2	
HYDROGEN (H=1)			
Hydric chloride . . .	HCl	36·5	Cl 97·26 ; H 2·74
,, nitrate, . . .	HNO_3	63	N_2O_5 85·72 ; OH_2 14·28
,, sulphate, . . .	H_2SO_4	98	SO_3 81·64 ; OH_2 18·36
IRON (Fe=56)			
Ferrous chloride, . . .	$FeCl_2$	127	Fe 44·09 ; Cl 55·91
,, oxide, ...	FeO	72	Fe 77·78 ; O 22·22
,, sulphide, . . .	FeS	88	Fe 63·64 ; S 36·36
,, sulphate, . . .	$FeSO_4$, $7OH_2$	152+126=278	(crystals) FeO 25·90 ; SO_3 28·78 ; OH_2 45·32

FORMULÆ, MOLECULAR WEIGHTS, AND PERCENTAGE COMPOSITIONS OF COMMONLY OCCURRING COMPOUNDS—*continued.*

Name.	Formula.	Molecular Weight.	Percentage Composition.
Ferrous ammonic sulphate,	$Fe(NH_4)_2 2SO_4, 6OH_2$	284 + 108 = 392	Contains 1/7th of its weight of iron, or 14·286 per cent.
,, nitrate,	$Fe(NO_3)_2, 6OH_2$	180 + 108 = 288	
,, carbonate,	$FeCO_3$	116	Fe 48·27 or FeO 62·07; CO_2 37·93
Ferric chloride,	Fe_2Cl_6	325	Fe 34·46; Cl 65·54
,, oxide,	Fe_2O_3	160	Fe 70; O 30
Triferric tetroxide,	Fe_3O_4	232	Fe 72·41; O 27·59
Ferric disulphide,	FeS_2	120	Fe 46·67; S 53·33
,, sulphate,	$Fe_2(SO_4)_3$	400	
LEAD (Pb = 206·5)			
Plumbic chloride,	$PbCl_2$	277·5	Pb 74·46; Cl 25·54
,, oxide,	PbO	222·5	Pb 92·81; O 7·19
,, dioxide,	PbO_2	238·5	Pb 86·58; O 13·42
,, sulphide,	PbS	238·5	Pb 86·58; S 13·42
,, sulphate,	$PbSO_4$	302·5	PbO 73·55; SO_3 26·45
,, nitrate,	$Pb(NO_3)_2$	330·5	PbO 67·32; N_2O_5 32·68
,, acetate,	$Pb(C_2H_3O_2)_2$	324·5	
,, chromate,	$PbCrO_4$	322·5	PbO 68·99 (= Pb 64·03); CrO_3 31·01
MAGNESIUM (Mg = 24)			
Magnesic chloride,	$MgCl_2$	95	Mg 25·26; Cl 74·74
,, oxide,	MgO	40	Mg 60; O 40
,, carbonate,	$MgCO_3$	84	MgO 47·62; CO_2 52·38
,, sulphate,	$MgSO_4, 7OH_2$	120 + 126 = 246	(cryst.) MgO 16·26; SO_3 32·52; OH_2 51·22 (anhydrous) Mg O 33·33; SO_3 66·67

Magnesic ammonic phosphate,	$Mg_2(NH_4)_2(PO_4)_2, 12OH_2$	274 + 216 = 490	
„ pyrophosphate,	$Mg_2P_2O_7$	222	MgO 36·04 ; P_2O_5 63·96
MANGANESE (Mn = 55)			
Manganous carbonate,	$MnCO_3$	115	
„ chloride,	$MnCl_2, 4OH_2$	126 + 72 = 198	(anhydr.) Mn 43·65 ; Cl 56·35
„ oxide,	MnO	71	Mn 77·47 ; O 22·53
„ sulphate,	$MnSO_4, 5OH_2$	151 + 90 = 241	(anhydr.) MnO 47·02 ; SO_3 52·98
Manganic dioxide,	MnO_2	87	Mn 63·22 ; O 36·78
„ sesquioxide,	Mn_2O_3	158	Mn 69·62 ; O 30·38
Trimanganic tetroxide,	Mn_3O_4	229	Mn 72·05 ; O 27·95
MERCURY (Hg = 200)			
Mercurous chloride,	Hg_2Cl_2	471	Hg 84·93 ; Cl 15·07
„ oxide,	Hg_2O	416	Hg 96·15 ; O 3·85
„ nitrate,	$Hg_2(NO_3)_2, 2OH_2$	524 + 36 = 560	
Mercuric chloride,	$HgCl_2$	271	Hg 73·80 ; Cl 26·20
„ iodide,	HgI_2	453·2	Hg 44·05 ; I 55·95
„ oxide,	HgO	216	Hg 92·59 ; O 7·41
„ sulphide,	HgS	232	Hg 86·21 ; O 13·79
„ sulphate,	$HgSO_4$	296	
„ nitrate,	$2Hg(NO_3)_2, OH_2$	2 × 324 + 18 = 666	
NICKEL (Ni = 59)			
Nickelous chloride,	$NiCl_2$	130	
„ oxide,	NiO	75	Ni 78·67 ; O 21·33
„ sulphate,	$NiSO_4, 7OH_2$	155 + 126 = 281	
PHOSPHORUS (P = 31)			
Hypophosphorous acid,	HPH_2O_2	66	
Phosphorous „	H_2PHO_3	82	

FORMULÆ, MOLECULAR WEIGHTS, AND PERCENTAGE COMPOSITIONS OF COMMONLY OCCURRING COMPOUNDS—*continued.*

Name.	Formula.	Molecular Weight.	Percentage Composition.
Phosphoric acid,	H_3PO_4	98	P_2O_5 72·45 ; OH_2 27·55
Metaphosphoric acid,	HPO_3	80	P_2O_5 88·75 ; OH_2 11·25
Pyrophosphoric ,,	$H_4P_2O_7$	178	P_2O_5 79·77 ; OH_2 20·23
Phosphoric anhydride,	P_2O_5	142	P 43·66 ; O 56·34
PLATINUM (Pt = 197·2)			
Platinic chloride,	$PtCl_4$	339·2	Pt 58·12 ; Cl 41·88
Ammonic platinic chloride,	$PtCl_4$, $2NH_4Cl$	446·2	Pt 44·18 ; NH_3 7·62 (N 6·28)
Potassic platinic chloride,	$PtCl_4$, 2KCl	488·2	Pt 40·39 ; Cl 43·63 ; K 15·98 (= K_2O 19·25 or KCl 30·52)
POTASSIUM (K = 39)			
Potassic carbonate,	K_2CO_3	138	K_2O 68·12 ; CO_2 31·88
,, bicarbonate,	$KHCO_3$	100	K_2O 47·00 ; CO_2 44·00 ; OH_2 9·00
,, chlorate,	$KClO_3$	122·5	K_2O 38·42 ; Cl_2O_5 61·58
,, chloride,	KCl	74·5	K 52·38 ; Cl 47·62
,, chromate,	K_2CrO_4	194·5	
,, bichromate,	$K_2Cr_2O_7$	295	K_2O 31·86 ; CrO_3 68·14
,, cyanide,	KCN	65	
,, ferrocyanide,	$K_4FeC_6N_6$, $3OH_2$	368 + 54 = 422	K 37·03 ; Fe 13·25 ; CN 36·93 ; OH_2 12·79
,, ferricyanide,	$K_6Fe_2C_{12}N_{12}$	658	K 35·56 ; Fe 17·02 ; CN 47·42
,, hydrate,	KHO	56	K_2O 83·93 ; OH_2 16·07
,, iodide,	KI	165·6	K 23·51 ; I 76·49
,, hydric metantimoniate,	$K_2H_2Sb_2O_7$, $6OH_2$	432 + 108	
,, nitrate,	KNO_3	101	K_2O 46·53 ; N_2O_5 53·47

Potassic nitrite,	KNO_2	85	
,, oxide,	K_2O	94	K 82·98 ; O 17·02
,, permanganate,	$K_2Mn_2O_8$	316	K_2O 29·75 ; Mn_2O_7 70·25
,, sulphate,	K_2SO_4	174	K_2O 54·03 ; SO_3 45·97
,, bisulphate,	$KHSO_4$	136	K_2O 34·56 ; SO_3 58·83 ; OH_2 6·62
,, bromide,	KBr	119	K 32·80 ; Br 67·20
SILICON (Si = 28·3)			
Silica,	SiO_2	60·3	Si 46·93 ; O 53·07
SILVER (Ag = 107·7)			
Silver chloride,	AgCl	143·2	Ag 75·21 ; Cl 24·79
,, bromide,	AgBr	187·7	Ag 57·38 ; Br 42·62
,, nitrate,	$AgNO_3$	169·7	Ag_2O 68·18 or Ag 63·47 ; N_2O_5 31·82
,, sulphate,	Ag_2SO_4	311·4	Ag_2O 74·31 ; SO_3 25·69
SODIUM (Na = 23)			
Sodic aluminate,	$Na_6Al_2O_6$	289	Na_2O 64·36 ; Al_2O_3 35·64
,, biborate,	$Na_2B_4O_7$, $10OH_2$	202 + 180 = 382	(anhydr.) Na_2O 30·69 ; B_2O_3 69·31 (cryst.) Na_2O 16·23 ; B_2O_3 36·65 ; OH_2 47·12
,, carbonate,	Na_2CO_3, $10OH_2$	106 + 180 = 286	(anhydr.) Na_2O 58·49 ; CO_2 41·51 (cryst.) Na_2O 21·68 ; CO_2 15·39 ; OH_2 62·93
,, bicarbonate,	$NaHCO_3$	84	Na_2O 36·90 ; CO_2 52·38 ; OH_2 10·71
,, chloride,	NaCl	58·5	Na 39·32 ; Cl 60·68
,, oxide,	Na_2O	62	Na 74·19 ; O 25·81
,, hydrate,	NaHO	40	Na_2O 77·50 ; OH_2 22·50
,, nitrate,	$NaNO_3$	85	N 16·47
Trisodic phosphate,	Na_3PO_4, $12OH_2$	164 + 216	
Hydric disodic phosphate,	Na_2HPO_4, $12OH_2$	142 + 216	Na_2O 17·32 ; P_2O_5 19·84 ; OH_2 62·84

FORMULÆ, MOLECULAR WEIGHTS, AND PERCENTAGE COMPOSITIONS OF COMMONLY OCCURRING COMPOUNDS—*continued.*

Name.	Formula.	Molecular Weight.	Percentage Composition.
Sodic sulphate, ...	Na_2SO_4, $10OH_2$	142+180=322	(anhydr.) Na_2O 43·67 ; SO_3 56·33 (cryst.) Na_2O 19·26 ; SO_3 24·84 ; OH_2 55·90
,, bisulphate, . . .	$NaHSO_4$	120	Na_2O 25·83 ; SO_3 66·67 ; OH_2 7·50
,, sulphite, ...	Na_2SO_3, $10OH_2$	126+180	
,, nitroprusside, . . .	$Na_2(NO)FeCy_5$, $2OH_2$	262+36	
,, thiosulphate, . . .	$Na_2S_2O_3$, $5OH_2$	158+90=248	Na_2O 25·00; S 12·90; SO_2 25·80; OH_2 36·30
STRONTIUM (Sr=87·4)			
Strontic chloride, . . .	$SrCl_2$, $6OH_2$	158·4+108	
,, carbonate, . . .	$SrCO_3$	147·4	SrO 70·15; CO_2 29·85
,, nitrate, . . .	$SrNO_3$	211·4	
,, sulphate, . . .	$SrSO_4$	183·4	SrO 56·41 ; SO_3 43·59
TIN (Sn=118)			
Stannous chloride, . . .	$SnCl_2$, $2OH_2$	225	Sn 52·44 ; Cl 31·56 ; OH_2 16·00
Stannic oxide, ...	SnO_2	150	Sn 78·66; O 21·34
ZINC (Zn=65)			
Zincic chloride, . . .	$ZnCl_2$	136	Zn 47·79 ; Cl 52·21
,, oxide, ...	ZnO	81	Zn 80·25 ; O 19·75
,, sulphate, . . .	$ZnSO_4$, $7OH_2$	161+126	(anhydr.) Zn O 50·31 ; SO_3 49·69
,, carbonate, . . .	$ZnCO_3$	125	Zn O 64·80 ; CO_2 35·20 or Zn 52 ; CO_3 48.

The Molecular Weights and Weights of one Litre of various Gases.

Name.	Formula.	Molecular Weight.	Weight of 1 litre at 0° C. and 760 mm. Bar.
			grammes.
Ammonia, ...	NH_3	17	0·7616
Carbon monoxide, . .	CO	28	1·2544
,, dioxide, . . .	CO_2	44	1·9774
Methane, ...	CH_4	16	0·7168
Cyanogen, ...	C_2N_2	52	2·3296
Chlorine, ...	Cl_2	71	3·1808
Hydrogen, ...	H_2	2	0·0896
Hydrogen bromide, . .	HBr	81	3·6288
,, chloride, . .	HCl	36·5	1·6352
,, fluoride, . .	HF	20	0·8960
,, iodide, . . .	HI	127·6	5·7165
,, sulphide, . .	H_2S	34	1·5475
Nitrogen, ...	N_2	28	1·2562
Nitrous oxide, . .	N_2O	44	1·9774
Nitric ,, . .	NO	30	1·3440
,, peroxide, . . .	NO_2	46	2·0608
Oxygen, ...	O_2	32	1·4298
Sulphur dioxide, . . .	SO_2	64	2·8672
Atmospheric air, . . .	...	...	1·2932

Multipliers and their Logarithms required in Gravimetric Analysis.

Element.	To convert	Fractional Multiplier.*	Decimal Multiplier.	Logarithm (to be *added*).
	Aluminium (Al = 27·0)			
Al	Al_2O_3 into Al_2	$\frac{54}{102}$	0·5294	$\bar{1}$·72379
,,	,, ,, ammonia-alum	$\frac{906}{102}$	8·8824	0·94853
,,	,, ,, potash-alum	$\frac{948}{102}$	9·2941	0·96821
,,	$Al_2(PO_4)_2$,, Al_2O_3	$\frac{102}{244}$	0·4180	$\bar{1}$·62121
,,	,, ,, ammonia-alum	$\frac{906}{244}$	3·7131	0·56974
,,	Milligrams of $Al_2P_2O_8$ per 100 grams bread *into* grains of ammonia-alum per 4 lb. loaf, . . .	...	1·0397	0·01690

* The figures given in this column are the molecular weights unreduced.

Multipliers and their Logarithms required in Gravimetric Analysis—*continued.*

Element.	To convert			Fractional Multiplier.	Decimal Multiplier.	Logarithm (to be *added*).
	Antimony (Sb = 120)					
Sb	Sb_2O_4	into	Sb_2	$\frac{240}{304}$	0·7895	$\bar{1}$·89734
,,	Sb_2S_3	,,	Sb_2	$\frac{240}{336}$	0·7143	$\bar{1}$·85387
	Arsenic (As = 75)					
As	$2NH_4MgAsO_4, OH_2$	into	As_2	$\frac{150}{380}$	0·3947	$\bar{1}$·59631
,,	,,	,,	As_2O_3	$\frac{198}{380}$	0·5211	$\bar{1}$·71689
,,	,,	,,	As_2O_5	$\frac{230}{380}$	0·6053	$\bar{1}$·78194
,,	$Mg_2As_2O_7$	,,	As_2	$\frac{150}{310}$	0·4839	$\bar{1}$·68473
,,	,,	,,	As_2O_3	$\frac{198}{310}$	0·6387	$\bar{1}$·80530
,,	,,	,,	As_2O_5	$\frac{230}{310}$	0·7419	$\bar{1}$·87037
,,	As_2O_3	,,	As_2	$\frac{150}{198}$	0·7576	$\bar{1}$·87942
,,	As_2S_3	,,	As_2	$\frac{150}{246}$	0·6098	$\bar{1}$·78516
,,	,,	,,	As_2O_3	$\frac{198}{246}$	0·8049	$\bar{1}$·90573
,,	,,	,,	As_2O_5	$\frac{230}{246}$	0·9350	$\bar{1}$·97079
	Barium (Ba = 137)					
Ba	$BaSO_4$	into	Ba	$\frac{137}{233}$	0·5880	$\bar{1}$·76936
,,	,,	,,	BaO	$\frac{153}{233}$	0·6567	$\bar{1}$·81734
,,	,,	,,	$BaCO_3$	$\frac{197}{233}$	0·8455	$\bar{1}$·92711
,,	,,	,,	$BaCl_2$	$\frac{208}{233}$	0·8927	$\bar{1}$·95071
,,	,,	,,	$BaCl_2, 2OH_2$	$\frac{244}{233}$	1·0472	0·02003
,,	,,	,,	S	$\frac{32}{233}$	0·1373	$\bar{1}$·13779
,,	,,	,,	SO_3	$\frac{80}{233}$	0·3434	$\bar{1}$·53573
,,	,,	,,	SO_4	$\frac{96}{233}$	0·4120	$\bar{1}$·61492
,,	,,	,,	H_2SO_4	$\frac{98}{233}$	0·4206	$\bar{1}$·62387
,,	,,	,,	$CaSO_4$	$\frac{136}{233}$	0·5837	$\bar{1}$·76618
,,	,,	,,	$CaSO_4, 2OH_2$	$\frac{172}{233}$	0·7382	$\bar{1}$·86817
,,	,,	,,	K_2SO_4	$\frac{174}{233}$	0·7468	$\bar{1}$·87319
,,	,,	,,	Na_2SO_4	$\frac{142}{233}$	0·6094	$\bar{1}$·78493
,,	,,	,,	$(NH_4)_2SO_4$	$\frac{132}{233}$	0·5665	$\bar{1}$·75322
,,	,,	,,	2KHO	$\frac{112}{233}$	0·4807	$\bar{1}$·68186
,,	$2BaSO_4$	,,	FeS_2	$\frac{120}{466}$	0·2575	$\bar{1}$·41080
,,	$BaCO_3$	,,	Ba	$\frac{137}{197}$	0·6954	$\bar{1}$·84225
,,	,,	,,	BaO	$\frac{153}{197}$	0·7767	$\bar{1}$·89023
,,	,,	,,	CO_3	$\frac{60}{197}$	0·3046	$\bar{1}$·48369

MULTIPLIERS AND THEIR LOGARITHMS REQUIRED IN GRAVIMETRIC ANALYSIS—*continued.*

Element.	To convert			Fractional Multiplier.	Decimal Multiplier.	Logarithm (to be *added*).
		BISMUTH (Bi = 208)				
Bi	Bi_2O_3	into	Bi_2	$\frac{416}{464}$	0·8966	$\bar{1}$·95258
,,	Bi_2S_3	,,	Bi_2	$\frac{416}{512}$	0·8125	$\bar{1}$·90982
		BORON (B = 11)				
B	B_2O_3	into	B_2	$\frac{22}{70}$	0·3143	$\bar{1}$·49732
		CADMIUM (Cd = 112)				
Cd	CdO	into	Cd	$\frac{112}{128}$	0·8750	$\bar{1}$·94201
,,	CdS	,,	Cd	$\frac{112}{144}$	0·7778	$\bar{1}$·89086
,,	,,	,,	CdO	$\frac{128}{144}$	0·8889	$\bar{1}$·94885
		CALCIUM (Ca = 40)				
Ca	CaO	into	Ca	$\frac{40}{56}$	0·7143	$\bar{1}$·85387
,,	,,	,,	$CaCO_3$	$\frac{100}{56}$	1·7857	0·25181
,,	,,	,,	$CaSO_4$	$\frac{136}{56}$	2·4286	0·38535
,,	,,	,,	$CaSO_4, 2OH_2$	$\frac{172}{56}$	3·0714	0·48734
,,	,,	,,	$CaCl_2$	$\frac{111}{56}$	1·9822	0·29714
,,	CaO	,,	CaH_2O_2	$\frac{74}{56}$	1·3214	0·12104
,,	$CaCl_2$	,,	CaO	$\frac{56}{111}$	0·5045	$\bar{1}$·70287
,,	,,	,,	Cl_2	$\frac{71}{111}$	0·6396	$\bar{1}$·80594
,,	$CaCO_3$	,,	Ca	$\frac{40}{100}$	0·4	$\bar{1}$·60206
,,	,,	,,	CaO	$\frac{56}{100}$	0·56	$\bar{1}$·74819
,,	,,	,,	CO_2	$\frac{44}{100}$	0·44	$\bar{1}$·64345
,,	,,	,,	CO_3	$\frac{60}{100}$	0·6	$\bar{1}$·77815
,,	,,	,,	$CaSO_4$	$\frac{136}{100}$	1·36	0·13354
,,	,,	,,	$CaSO_4, 2OH_2$	$\frac{172}{100}$	1·72	0·23553
,,	$CaSO_4$	,,	Ca	$\frac{40}{136}$	0·2941	$\bar{1}$·46852
,,	,,	,,	CaO	$\frac{56}{136}$	0·4118	$\bar{1}$·61465
,,	,,	,,	$CaCO_3$	$\frac{100}{136}$	0·7353	$\bar{1}$·86646
,,	,,	,,	$CaSO_4, 2OH_2$	$\frac{172}{136}$	1·2647	0·10199
,,	,,	,,	SO_3	$\frac{80}{136}$	0·5882	$\bar{1}$·76955
,,	$Ca_3P_2O_8$	,,	CaP_2O_6	$\frac{198}{310}$	0·6387	$\bar{1}$·80530
,,	,,	,,	P_2O_5	$\frac{142}{310}$	0·4581	$\bar{1}$·66093
,,	,,	,,	P_2	$\frac{62}{310}$	0·2	$\bar{1}$·30103

MULTIPLIERS AND THEIR LOGARITHMS REQUIRED IN GRAVIMETRIC ANALYSIS—*continued.*

Element.	To convert			Fractional Multiplier.	Decimal Multiplier.	Logarithm (to be *added*).
		CARBON ($C = 12$)				
C	CO_2	into	C	$\frac{12}{44}$	0·2727	$\bar{1}$·43573
,,	,,	,,	$CaCO_3$	$\frac{100}{44}$	2·2727	0·35655
,,	,,	,,	Na_2CO_3	$\frac{106}{44}$	2·4091	0·38185
,,	$2CO_2$	,,	MnO_2	$\frac{86}{88}$	0·9773	$\bar{1}$·99002
		CHLORINE ($Cl = 35·5$)				
Cl	Cl	into	HCl	$\frac{36·5}{35·5}$	1·0282	0·01206
,,	,,	,,	NaCl	$\frac{58·5}{35·5}$	1·6479	0·21693
,,	Cl_2	,,	$MgCl_2$	$\frac{95}{71}$	1·3380	0·12647
,,	,,	,,	O	$\frac{16}{71}$	0·2254	$\bar{1}$·35286
,,	,,	,,	$CaCl_2$	$\frac{111}{71}$	1·5634	0·19406
		CHROMIUM ($Cr = 52·5$)				
Cr	Cr_2O_3	into	Cr_2	$\frac{105}{153}$	0·6863	$\bar{1}$·83650
		COBALT ($Co = 59$)				
Co	CoO	into	Co	$\frac{59}{75}$	0·7867	$\bar{1}$·89579
		COPPER ($Cu = 63·2$)				
Cu	CuO	into	Cu	$\frac{63·2}{79·2}$	0·7980	$\bar{1}$·90199
,,	2CuO	,,	Cu_2O	$\frac{142·4}{158·4}$	0·8990	$\bar{1}$·95375
,,	Cu_2O	,,	2CuO	$\frac{158·4}{142·4}$	1·1124	0·04625
,,	$Cu_2(CNS)_2$	,,	Cu_2	$\frac{126·4}{242·4}$	0·5215	$\bar{1}$·71721
		FLUORINE ($F = 19$)				
F	CaF_2	into	F_2	$\frac{38}{78}$	0·4872	$\bar{1}$·68769
		HYDROGEN ($H = 1$)				
H	H_2SO_4	into	2HCl	$\frac{73}{98}$	0·7449	$\bar{1}$·87210
,,	,,	,,	$(NH_4)_2SO_4$	$\frac{132}{98}$	1·3470	0·12935
,,	HCl	,,	Cl	$\frac{35·5}{36·5}$	0·9726	$\bar{1}$·98794
,,	HNO_3	,,	N	$\frac{14}{63}$	0·2222	$\bar{1}$·34679
		IRON ($Fe = 56$)				
Fe	Fe	into	FeO	$\frac{72}{56}$	1·2857	0·10914
,,	,,	,,	$FeSO_4, 7OH_2$	$\frac{278}{56}$	4·9643	0·69586
,,	,,	,,	FeS_2	$\frac{120}{56}$	2·1429	0·33099

Multipliers and their Logarithms required in Gravimetric Analysis—*continued.*

Element.	To convert			Fractional Multiplier.	Decimal Multiplier.	Logarithm (to be *added*).
	Iron (Fe = 56)—*continued.*					
Fe	Fe_2	into	MnO_2	$\frac{87}{112}$	0·7768	$\bar{1}$·89030
,,	,,	,,	$Fe_2(PO_4)_2$	$\frac{302}{112}$	2·6964	0·43079
,,	,,	,,	Fe_2O_3	$\frac{160}{112}$	1·4286*	0·15490
,,	Fe_2O_3	,,	Fe_2	$\frac{112}{160}$	0·7	$\bar{1}$·84510
,,	,,	,,	$Fe_2\ (PO_4)_2$	$\frac{302}{160}$	1·8875	0·27589
,,	$3Fe_2O_3$	,,	$2Fe_3O_4$	$\frac{464}{480}$	0·9667	$\bar{1}$·98528
,,	FeS_2	,,	S_2	$\frac{64}{120}$	0·5333	$\bar{1}$·72700
,,	FeS	,,	Fe	$\frac{56}{88}$	0·6364	$\bar{1}$·80371
,,	$2FeS$	,,	Fe_2O_3	$\frac{160}{176}$	0·9091	$\bar{1}$·95861
,,	$2Fe(NH_4)_2(SO_4)_2,\ 6OH_2$	into	MnO_2	$\frac{87}{784}$	0·1110	$\bar{1}$·04520
	Lead (Pb = 206·5)					
Pb	PbS	into	Pb	$\frac{206\cdot5}{238\cdot5}$	0·8658	$\bar{1}$·93743
,,	,,	,,	PbO	$\frac{222\cdot5}{238\cdot5}$	0·9329	$\bar{1}$·96984
,,	$PbSO_4$	,,	Pb	$\frac{206\cdot5}{302\cdot5}$	0·6826	$\bar{1}$·83419
,,	,,	,,	PbO	$\frac{222\cdot5}{302\cdot5}$	0·7355	$\bar{1}$·86660
,,	$PbCrO_4$	,,	Pb	$\frac{206\cdot5}{323}$	0·6393	$\bar{1}$·80572
,,	,,	,,	PbO	$\frac{222\cdot5}{323}$	0·6889	$\bar{1}$·83813
,,	$2PbCrO_4$	,,	$K_2Cr_2O_7$	$\frac{295}{646}$	0·4567	$\bar{1}$·65959
	Magnesium (Mg = 24)					
Mg	$MgCl_2$	into	MgO	$\frac{40}{95}$	0·4210	$\bar{1}$·62434
,,	,,	,,	Cl_2	$\frac{71}{95}$	0·7474	$\bar{1}$·87353
,,	MgO	,,	$MgCO_3$	$\frac{84}{40}$	2·1	0·32222
,,	,,	,,	$MgCl_2$	$\frac{95}{40}$	2·375	0·37566
,,	,,	,,	$MgSO_4$	$\frac{120}{40}$	3	0·47712
,,	,,	,,	$Mg(NO_3)_2$	$\frac{148}{40}$	3·7	0·56820
,,	$Mg_2P_2O_7$	,,	Mg_2	$\frac{48}{222}$	0·2162	$\bar{1}$·33489
,,	,,	,,	$2MgO$	$\frac{80}{222}$	†0·3604	$\bar{1}$·55674
,,	,,	,,	$2MgCO_3$	$\frac{168}{222}$	0·7568	$\bar{1}$·87896
,,	,,	,,	$2MgSO_4$	$\frac{240}{222}$	1·0811	0·03386
,,	,,	,,	$2(MgSO_4,\ 7OH_2)$	$\frac{492}{222}$	2·2162	0·34561
,,	,,	,,	$CaH_4P_2O_8$	$\frac{234}{222}$	1·0541	0·02286

* Or divide by 0·7.

† Or use the Phosphate Table, pp. 64–71, subtracting from the $Mg_2\ P_2O_7$ found the P_2O_5 in it.

Multipliers and their Logarithms required in Gravimetric Analysis—*continued.*

Element.	To convert			Fractional Multiplier.	Decimal Multiplier.	Logarithm (to be *added*)
	Magnesium (Mg = 24)—*continued.*					
Mg	$Mg_2P_2O_7$	,,	P_2	$\frac{62}{222}$	0·2793	$\bar{1}$·44604
,,	,,	,,	P_2O_5	$\frac{142}{222}$	0·6396	$\bar{1}$·80594
,,	,,	,,	CaP_2O_6	$\frac{198}{222}$	0·8919	$\bar{1}$·95031
,,	,,	,,	$Ca_3P_2O_8$	$\frac{310}{222}$	1·3964	0·14501
,,	$MgSO_4$	,,	Mg	$\frac{24}{120}$	0·2	$\bar{1}$·30103
,,	,,	,,	MgO	$\frac{40}{120}$	0·3333	$\bar{1}$·52288
	Manganese (Mn = 55)					
Mn	Mn	into	MnO	$\frac{71}{55}$	1·2909	0·11090
,,	MnO	,,	Mn	$\frac{55}{71}$	0·7747	$\bar{1}$·88910
,,	MnO_2	,,	Mn	$\frac{55}{87}$	0·6322	$\bar{1}$·80084
,,	Mn_3O_4	,,	3Mn	$\frac{165}{229}$	0·7205	$\bar{1}$·85765
,,	,,	,,	3MnO	$\frac{213}{229}$	0·9301	$\bar{1}$·96854
,,	MnS	,,	Mn	$\frac{55}{87}$	0·6322	$\bar{1}$·80084
,,	,,	,,	MnO	$\frac{71}{87}$	0·8161	$\bar{1}$·91174
,,	$MnSO_4$	,,	Mn	$\frac{55}{151}$	0·3642	$\bar{1}$·56139
,,	,,	,,	MnO	$\frac{71}{151}$	0·4702	$\bar{1}$·67228
	Mercury (Hg = 200)					
Hg	HgS	into	Hg	$\frac{200}{232}$	0·8621	$\bar{1}$·93554
,,	,,	,,	HgO	$\frac{216}{232}$	0·9310	$\bar{1}$·96897
,,	Hg_2Cl_2	,,	2Hg	$\frac{400}{471}$	0·8493	$\bar{1}$·92904
,,	,,	,,	Hg_2O	$\frac{416}{471}$	0·8832	$\bar{1}$·94607
	Molybdenum.					
Mo	Ammonic phosphomolybdate	into	P		0·0163	$\bar{2}$·21219
,,	,,	,, into	P_2O_5		0·0373	$\bar{2}$·57208
,,	,,	,, ,,	$Ca_3P_2O_8$		0 0815	$\bar{2}$·91116
	Nickel (Ni = 58·6)					
Ni	NiO	into	Ni	$\frac{58 \cdot 6}{74 \cdot 6}$	0·7855	$\bar{1}$ 89516
	Nitrogen and Ammonium (N = 14)					
N	N	into	NH_3	$\frac{17}{14}$	1·2143	0·08432
,,	,,	,,	HNO_3	$\frac{63}{14}$	4·5	0·65321
,,	,,	,,	$NaNO_3$	$\frac{85}{14}$	6·0714	0·78329
,,	,,	,,	KNO_3	$\frac{101}{14}$	7·2142	0·85819
,,	,,	,,	Albuminoids		6·25	0·79588

Multipliers and their Logarithms required in Gravimetric Analysis—*continued.*

Element.	To convert			Fractional Multiplier.	Decimal Multiplier.	Logarithm (to be *added*).
	Nitrogen and Ammonium ($N=14$) —*continued.*					
N	N_2	into	N_2O_5	$\frac{108}{28}$	3·8572	0·58627
,,	N_2O_5	,,	N_2	$\frac{28}{108}$	0·2593	$\bar{1}\cdot41373$
,,	,,	,,	$2KNO_3$	$\frac{202}{108}$	1·8704	0·27193
,,	,,	,,	$Ca(NO_3)_2$	$\frac{164}{108}$	1·5185	0·18142
,,	,,	,,	$Mg(NO_3)_2$	$\frac{148}{108}$	1·3704	0·13684
,,	NH_3	,,	N	$\frac{14}{17}$	0·8235	$\bar{1}\cdot91568$
,,	,,	,,	NH_4Cl	$\frac{53\cdot5}{17}$	3·1470	0·49790
,,	$2NH_3$	,,	$(NH_4)_2SO_4$	$\frac{132}{34}$	3·8824	0·58910
,	NH_4Cl	,,	N	$\frac{14}{53\cdot5}$	0·2617	$\bar{1}\cdot41777$
,,	,,	,,	NH_3	$\frac{17}{53\cdot5}$	0·3178	$\bar{1}\cdot50210$
,,	$(NH_4)_2SO_4$	,,	H_2SO_4	$\frac{98}{132}$	0·7424	$\bar{1}\cdot87065$
,,	,,	,,	$2NH_3$	$\frac{34}{132}$	0·2576	$\bar{1}\cdot41091$
,,	,,	,,	N_2	$\frac{28}{132}$	0·2121	$\bar{1}\cdot32658$
,,	Ammonia-alum	,,	Potash-alum	$\frac{948}{906}$	1·0464	0·01968
	Phosphorus ($P=31$)					
P	P_2	into	P_2O_5	$\frac{142}{62}$	2·2903	0·35990
,,	P_2O_5	,,	P_2	$\frac{62}{142}$	0·4366	$\bar{1}\cdot64010$
,,	,,	,,	$Ca_3P_2O_8$	$\frac{310}{142}$	2·1831	0·33907
	Platinum ($Pt=197\cdot2$)					
Pt	$(NH_4)_2PtCl_6$	into	N_2	$\frac{28}{446\cdot2}$	0·0628	$\bar{2}\cdot79763$
,,	,,	,,	$2NH_3$	$\frac{34}{446\cdot2}$	0·0762	$\bar{2}\cdot88195$
,,	,,	,,	$2NH_4Cl$	$\frac{107}{446\cdot2}$	0·2398	$\bar{1}\cdot37985$
,,	,,	,,	$2NH_4$	$\frac{36}{446\cdot2}$	0·0807	$\bar{2}\cdot90677$
,,	,,	,,	$(NH_4)_2SO_4$	$\frac{132}{446\cdot2}$	0·2958	$\bar{1}\cdot47104$
,,	K_2PtCl_6	,,	K_2	$\frac{78}{488\cdot2}$	0·1600	$\bar{1}\cdot20350$
,,	,,	,,	2KCl*	$\frac{149}{488\cdot2}$	0·3052	$\bar{1}\cdot48459$
,,	,,	,,	K_2O	$\frac{94}{488\cdot2}$	0·1925	$\bar{1}\cdot28453$
,,	,,	,,	K_2SO_4	$\frac{174}{488\cdot2}$	0·3564	$\bar{1}\cdot55195$
,,	Pt	,,	$2NH_4Cl$	$\frac{107}{197\cdot2}$	0·5426	$\bar{1}\cdot73448$
,,	,,	,,	$(NH_4)_2SO_4$	$\frac{132}{197\cdot2}$	0·6694	$\bar{1}\cdot82567$

* Using Tatlock's method of determining potash, the following *empirical* factors have been obtained and are frequently used:—

(i.) Tatlock's own factor is platinochloride pp. $\times 0\cdot3056 = KCl$.

(ii.) Dr Dittmar (see *Jour. Soc. Chem. Ind.*, 1887, p. 801) found platinochloride pp. $\times \cdot30627 = KCl$. and Pt. $\times \cdot76016 = KCl$.

(iii.) Dr Dyer, as the result of his own determinations, uses the factors:—

Platinochloride pp. $\times \cdot1955 = K_2O$.

,, $\times \cdot3094 = KCl$.

MULTIPLIERS AND THEIR LOGARITHMS REQUIRED IN GRAVIMETRIC ANALYSIS—*continued.*

Element.	To convert			Fractional Multiplier.	Decimal Multiplier.	Logarithm (to be *added*).
		POTASSIUM (K=39)				
K	K	into	KCl	$\frac{74\cdot5}{39}$	1·9103	0·28109
,,	K_2	,,	K_2O	$\frac{94}{78}$	1·2051	0·08103
,,	2KCl	,,	K_2O	$\frac{94}{149}$	0·6309	$\bar{1}$·79994
,,	KCl	,,	Cl	$\frac{35\cdot5}{74\cdot5}$	0·4765	$\bar{1}$·67807
,,	,,	,,	KHT	$\frac{188}{74\cdot5}$	2·5235	0·40200
,,	K_2O	,,	2KCl	$\frac{149}{94}$	1·5851	0·20006
,,	,,	,,	K_2SO_4	$\frac{174}{94}$	1·8511	0·26742
,,	,,	,,	$2KNO_3$	$\frac{202}{94}$	2·1490	0·33222
,,	,,	,,	Rochelle salt	$\frac{564}{94}$	6·0	0·77815
,,	,,	,,	K_2CO_3	$\frac{138}{94}$	1·4681	0·16675
,,	,,	,,	2KHO	$\frac{112}{94}$	1·1915	0·07609
,,	,,	,,	$2KHC_4H_4O_6$	$\frac{376}{94}$	4·0	0·60206
,,	K_2SO_4	,,	K_2O	$\frac{94}{174}$	0·5402	$\bar{1}$·73258
,,	KNO_3	,,	N	$\frac{14}{101}$	0·1386	$\bar{1}$·14181
		SILICON (Si=28·3)				
Si	SiO_2	into	Si	$\frac{28\cdot3}{60\cdot3}$	0·4693	$\bar{1}$·67147
		SILVER (Ag=107·7)				
Ag	AgBr	into	Br	$\frac{80}{187\cdot7}$	0·4262	$\bar{1}$·62963
,,	AgCl	,,	Ag	$\frac{107\cdot7}{143\cdot2}$	0·7521	$\bar{1}$·87627
,,	,,	,,	Cl	$\frac{35\cdot5}{143\cdot2}$	0·2479	$\bar{1}$·39429
,,	,,	,,	HCl	$\frac{36\cdot5}{143\cdot2}$	0·2549	$\bar{1}$·40635
,,	AgI	,,	I	$\frac{126\cdot5}{234\cdot2}$	0·5401	$\bar{1}$·73250
		SODIUM (Na=23)				
Na	Na	into	NaCl	$\frac{58\cdot5}{23}$	2·5435	0·40543
,,	Na_2	,,	Na_2O	$\frac{62}{46}$	1·3478	0·12963
,,	Na_2O	,,	2NaCl	$\frac{117}{62}$	1·8871	0·27579
,,	,,	,,	Na_2SO_4	$\frac{142}{62}$	2·2903	0·35990
,,	,,	,,	Na_2CO_3	$\frac{106}{62}$	1·7097	0·23291
,,	,,	,,	$2NaNO_3$	$\frac{170}{62}$	2·7419	0·43806
,,	,,	,,	2NaHO	$\frac{80}{62}$	1·2903	0·11070
,,	NaCl	,,	Cl	$\frac{35\cdot5}{58\cdot5}$	0·6068	$\bar{1}$·78307
,,	,,	,,	$NaHCO_3$	$\frac{84}{58\cdot5}$	1·4359	0·15712

MULTIPLIERS AND THEIR LOGARITHMS REQUIRED IN GRAVIMETRIC ANALYSIS—*continued.*

Element.	To convert			Fractional Multiplier.	Decimal Multiplier.	Logarithm (to be *added*).
	SODIUM (Na = 23)—*continued.*					
Na	2NaCl	into	Na_2O	$\frac{62}{117}$	0·5299	$\bar{1}$·72421
,,	,,	,,	Na_2CO_3	$\frac{106}{117}$	0·9060	$\bar{1}$·95712
,,	$NaNO_3$	,,	N	$\frac{14}{85}$	0·1647	$\bar{1}$·21671
,,	Na_2CO_3	,,	Na_2CO_3, $10OH_2$	$\frac{286}{106}$	2·6981	0·43106
,,	Na_2SO_4	,,	Na_2	$\frac{46}{142}$	0·3239	$\bar{1}$·51047
,,	,,	,,	Na_2O	$\frac{62}{142}$	0·4366	$\bar{1}$·64010
	STRONTIUM (Sr = 87·3)					
Sr	$SrCO_3$	into	Sr	$\frac{87\cdot3}{147\cdot3}$	0·5927	$\bar{1}$·77281
,,	$SrSO_4$	,,	Sr	$\frac{87\cdot3}{183\cdot3}$	0·4763	$\bar{1}$·67785
	SULPHUR (S = 32)					
S	SO_3	into	S	$\frac{32}{80}$	0·4	$\bar{1}$·60206
,,	,,	,,	$CaSO_4$	$\frac{136}{80}$	1·7	0·23045
,,	,,	,,	$CaSO_4$, $2OH_2$	$\frac{172}{80}$	2·15	0·33244
,,	,,	,,	Na_2SO_4	$\frac{142}{80}$	1·775	0·24920
	TIN (Sn = 118)					
Sn	SnO_2	into	Sn	$\frac{118}{150}$	0·7867	$\bar{1}$·89579
,,	Sn	,,	SnO_2	$\frac{150}{118}$	1·2712	0·10421
	ZINC (Zn = 65)					
Zn	Zn	into	ZnO	$\frac{81}{65}$	1·2462	0·09557
,,	,,	,,	$ZnCl_2$	$\frac{136}{65}$	2·0923	0·32063
,,	ZnO	,,	Zn	$\frac{65}{81}$	0·8025	$\bar{1}$·90443
,,	ZnS	,,	Zn	$\frac{65}{97}$	0·6701	$\bar{1}$·82614

Example.—1·327 grams of a substance gave 0·8470 gram $BaSO_4$: to find the percentages of SO_3 and S present respectively.

Since 1·327 grams give 0·847 gram $BaSO_4$ 100 grams will give $\frac{\cdot847 \times 100}{1\cdot327} = \frac{84\cdot70}{1\cdot327}$.

Taking logs. Log. 84·70 = 1·92788

,, 1·327 = 0·12287

(subtracting) $\bar{1}$·80501

Add log. (Ba SO_4 into SO_3) $\bar{1}$·53573

$\bar{1}$·34074 = 21·92 per cent. SO_3.

Add log. (SO_3 into S.) $\bar{1}$·60206

0·94280 = 8·77 per cent. S.

Rule.—First find the weight of the pp. that 100 parts of substance would give, then add the log. of the multiplier to get percentage of substance sought.

MULTIPLIERS AND THEIR LOGARITHMS REQUIRED IN GRAVIMETRIC ANALYSIS—*continued.*

Element.	To convert	Fractional Multiplier.	Decimal Multiplier.	Logarithm (to be *added*).

MULTIPLIERS AND THEIR LOGARITHMS REQUIRED IN GRAVIMETRIC ANALYSIS—*continued.*

Element.	To convert	Fractional Multiplier.	Decimal Multiplier.	Logarithm (to be *added*).

Multipliers required in Volumetric Analysis.

			Logarithms.
Normal H_2SO_4	1 c.c. = 0·049	gram H_2SO_4 . .	$\bar{2}$·690 1961
	,, = 0·048	,, SO_4 . .	$\bar{2}$·681 2412
	,, = 0·040	,, SO_3 . .	$\bar{2}$·602 0600
Normal HCl	1 c.c. = 0·0365	,, HCl . .	$\bar{2}$·562 2929
	,, = 0·0355	,, Cl . . .	$\bar{2}$·550 2284
Normal HNO_3	1 c.c. = 0·063	,, HNO_3 . .	$\bar{2}$·799 3405
	,, = 0·062	,, NO_3 . .	$\bar{2}$·792 3917
	,, = 0·054	,, N_2O_5 . .	$\bar{2}$·732 3938
Normal $H_2C_2O_4$	1 c.c. = 0·063	,, $H_2C_2O_4$, $2OH_2$	$\bar{2}$·799 3405
	,, = 0·045	,, $H_2C_2O_4$ . .	$\bar{2}$·653 2125
Normal NaHO	1 c.c. = 0·040	,, NaHO . .	$\bar{2}$·602 0600
	,, = 0·031	,, Na_2O . .	$\bar{2}$·491 3617
Normal KHO	1 c.c. = 0·056	,, KHO . .	$\bar{2}$·748 1880
	,, = 0·047	,, K_2O . .	$\bar{2}$·672 0979
Normal Na_2CO_3	1 c.c. = 0·053	,, Na_2CO_3 . .	$\bar{2}$·724 2759
	,, = 0·030	,, CO_3 . .	$\bar{2}$·477 1213
	,, = 0·022	,, CO_2 . .	$\bar{2}$·342 4227
Decinormal $AgNO_3$	1 c.c. = 0·0108	,, Ag . . .	$\bar{2}$·033 4238
	,, = 0·017	,, $AgNO_3$ . .	$\bar{2}$·230 4489
	,, = 0·00355	,, Cl . . .	$\bar{3}$·550 2284
Decinormal NaCl	1 c.c. = 0·00585	,, NaCl . .	$\bar{3}$·767 1559

Calcium (Ca = 40)	
1 c.c. $\frac{N}{10}$ permanganate = 0·0028 gram CaO . . .	$\bar{3}$·447 1580
,, ,, = 0·0050 gram $CaCO_3$ . .	$\bar{3}$·698 9700
,, ,, = 0·0086 gram $CaSO_4$, $2OH_2$.	$\bar{3}$·934 4985
,, normal oxalic acid = 0·0280 gram CaO . .	$\bar{2}$·447 1580
Cryst. oxalic acid × 0·444 = CaO	$\bar{1}$·647 3830
Double iron salt × 0·07143 = CaO	$\bar{2}$·853 8807
Chlorine (Cl = 35·37)	
1 c.c. $\frac{N}{10}$ silver solution = 0·003537 gram Cl . . .	$\bar{3}$·548 6351
,, ,, = 0·005837 gram NaCl . .	$\bar{3}$·766 1897
1 c.c. $\frac{N}{10}$ arsenious or hyposulphite solution = 0·003537 gram Cl	$\bar{3}$·548 6351
1 litre of chlorine at 0° C. and 760 mm. weighs 3·17 grams	0·501 0593
Chromium (Cr = 52·4)	
Metallic iron × 0·3123 = Cr	$\bar{1}$·494 5720
,, × 0·5981 = CrO_3	$\bar{1}$·776 7738
,, × 0·8784 = $K_2Cr_2O_7$	$\bar{1}$·943 6923
,, × 1·926 = $PbCrO_4$	0·284 6563
Double iron salt × 0·0446 = Cr	$\bar{2}$·649 3349
,, × 0·0854 = CrO_3	$\bar{2}$·931 4579
,, × 0·1255 = $K_2Cr_2O_7$	$\bar{1}$·098 6437
,, × 0·275 = $PbCrO_4$	$\bar{1}$·439 3327
1 c.c. $\frac{N}{10}$ solution = 0·003349 gram CrO_3 . . .	$\bar{3}$·524 9151
,, ,, = 0·00492 gram $K_2Cr_2O_7$	$\bar{3}$·691 9651

MULTIPLIERS REQUIRED IN VOLUMETRIC ANALYSIS—*continued.*

	Logarithms.
COPPER ($Cu=63$)	
1 c.c. $\frac{N}{10}$ solution $=0{\cdot}0063$ gram Cu	$\bar{3}{\cdot}799\ 3405$
Iron $\times 1{\cdot}125$ $=$ copper	$0{\cdot}051\ 1525$
Double iron salt $\times 0{\cdot}1607 =$ copper	$\bar{1}{\cdot}206\ 0159$
CYANOGEN ($CN=26$)	
1 c.c. $\frac{N}{10}$ silver solution $=$ 0·0052 gram CN . .	$\bar{3}{\cdot}716\ 0033$
,, ,, $=$ 0·0054 gram HCN . .	$\bar{3}{\cdot}732\ 3938$
,, ,, $=$ 0·01302 gram KCN . .	$\bar{2}{\cdot}114\ 6110$
,, $\frac{N}{10}$ iodine $=$ 0·003255 gram KCN . .	$\bar{3}{\cdot}512\ 5510$
POTASSIC FERROCYANIDE (K_4FeCy_6, $3OH_2=422$)	
Metallic iron $\times 7{\cdot}541 =$ cryst. potassic ferrocyanide	$0{\cdot}877\ 4289$
Double iron salt $\times 1{\cdot}077 =$,, ,, ,,	$0{\cdot}032\ 2157$
POTASSIC FERRICYANIDE ($K_6Fe_2Cy_{12}=658$)	
Metallic iron $\times 5{\cdot}88$ $=$ potassic ferricyanide . .	$0{\cdot}769\ 3773$
Double iron salt $\times 1{\cdot}68$ $=$,, ,, . .	$0{\cdot}225\ 3093$
$\frac{N}{10}$ Hyposulphite $\times 0{\cdot}0329 =$,, ,, . .	$\bar{2}{\cdot}517\ 1959$
GOLD ($Au=196{\cdot}5$)	
1 c.c. normal oxalic acid $=0{\cdot}0655$ gram gold . . .	$\bar{2}{\cdot}816\ 2413$
IODINE ($I=126{\cdot}5$)	
1 c.c. $\frac{N}{10}$ hyposulphite $=0{\cdot}01265$ gram iodine . . .	$\bar{2}{\cdot}102\ 0905$
IRON ($Fe=56$)	
1 c.c. $\frac{N}{10}$ permanganate, bichromate,	
or hyposulphite $=0{\cdot}0056$ Fe . .	$\bar{3}{\cdot}748\ 1880$
,, ,, $=0{\cdot}0072$ FeO . .	$\bar{3}{\cdot}857\ 3325$
,, ,, $=0{\cdot}0080$ Fe_2O_3 .	$\bar{3}{\cdot}903\ 0900$
LEAD ($Pb=206{\cdot}4$)	
1 c.c. $\frac{N}{10}$ permanganate $=0{\cdot}01032$ gram lead . . .	$\bar{2}{\cdot}013\ 6797$
1 c.c. normal oxalic acid $=0{\cdot}1032$ gram lead . . .	$\bar{1}{\cdot}013\ 6797$
Metallic iron $\times 1{\cdot}842 =$ lead	$0{\cdot}265\ 2896$
Double iron salt $\times 0{\cdot}263 =$,, ...	$\bar{1}{\cdot}419\ 9557$
MANGANESE ($Mn=55$)	
$MnO=71$. $MnO_2=87$.	
Metallic iron $\times 0{\cdot}491$ $=$ Mn	$\bar{1}{\cdot}691\ 0815$
,, $\times 0{\cdot}63393 =$ MnO	$\bar{1}{\cdot}802\ 0413$
,, $\times 0{\cdot}7768$ $=$ MnO_2	$\bar{1}{\cdot}890\ 3092$

MULTIPLIERS REQUIRED IN VOLUMETRIC ANALYSIS—*continued.*

	Logarithms.
MANGANESE ($Mn=55$)—*continued.*	
Double iron salt × 0·0911 = MnO	$\bar{2}$·959 5184
,, × 0·111 = MnO_2	$\bar{1}$·045 3230
Cryst. oxalic acid × 0·6916 = MnO_2	$\bar{1}$·839 8550
1 c.c. $\frac{N}{10}$ solution = 0·00355 gram MnO	$\bar{3}$·550 2284
,, ,, = 0·00435 gram MnO_2	$\bar{3}$·638 4893
MERCURY ($Hg=200$)	
Double iron salt × 0·5104 = Hg	$\bar{1}$·707 9107
,, × 0·6914 = $HgCl_2$	$\bar{1}$·839 7294
1 c.c. $\frac{N}{10}$ solution = 0·0200 gram Hg	$\bar{2}$·301 0300
,, ,, = 0·0208 gram Hg_2O	$\bar{2}$·318 0633
,, ,, = 0·0271 gram $HgCl_2$	$\bar{2}$·432 9693
NITROGEN AS NITRATES AND NITRITES	
$N_2O_5=108$. $N_2O_3=76$.	
Normal acid × 0·0540 = N_2O_5	$\bar{2}$·732 3938
,, × 0·1011 = KNO_3	$\bar{1}$·004 7512
Metallic iron × 0·3750 = HNO_3	$\bar{1}$·574 0313
,, × 0·6018 = KNO_3	$\bar{1}$·779 4522
,, × 0·3214 = N_2O_5	$\bar{1}$·507 0459
SILVER ($Ag=107·66$)	
1 c.c. $\frac{N}{10}$ NaCl = 0·010766 gram Ag	$\bar{2}$·032 0544
,, = 0·016966 ,, $AgNO_3$	$\bar{2}$·229 5795
SULPHURETTED HYDROGEN ($H_2S=34$)	
1 c.c. $\frac{N}{10}$ arsenious solution = 0·00255 gram H_2S	$\bar{3}$·406 5402
TIN ($Sn=118$)	
Metallic iron × 1·0536 = tin	0·022 6758
Double iron salt × 0·1505 = tin	$\bar{1}$·177 5365
Factor for $\frac{N}{10}$ iodine or permanganate solution 0·0059	$\bar{3}$·770 8520
ZINC ($Zn=65$)	
Metallic iron × 0·5809 = Zn	$\bar{1}$·764 1014
,, 0·724 = ZnO	$\bar{1}$·859 7386
Double iron salt × 0·08298 = Zn	$\bar{2}$·918 9734
,, 0·1034 = ZnO	$\bar{1}$·014 5205
1 c.c. $\frac{N}{10}$ solution = 0·00325 gram Zn	$\bar{3}$·511 8834

Notes on Logarithms.

Definition.—The logarithm of a number N is the value of x which satisfies the equation $a^x = N$, where a is some given number.

Thus if a be 10 (which is the *base* of Briggs' or the ordinary logarithms), the logarithm of 100 is 2, that of 1000 is 3 ; and that of any number between 100 and 1000 will be greater than 2 and less than 3, so that it may be represented by 2 followed by places of decimals.

By means of a table of logarithms two numbers may be *multiplied* together by *adding* their logarithms and *divided* by *subtracting* their logarithms, the result in each case being the number corresponding to the logarithm thus obtained. Also Involution, or raising of powers, is performed by multiplication of the logarithm of the number by the index of the power; and Evolution, or extraction of roots, by division of the logarithm of the number by the index of the root.

The integral part of a logarithm is called the *characteristic*, the decimal part the *mantissa.* The characteristic may be either positive or negative (*e.g.*, 2, $\bar{2}$),* but the mantissa is *always positive.* The mantissæ *only* are registered in the tables, the characteristics always being found by the following simple rules :—

(1) For numbers greater than unity, the characteristic is *one less* than the number of digits, and is *positive.*

(2) For numbers less than unity, the characteristic is *one greater* than the number of ciphers which precede the first significant figure, and is *negative.**

$$\begin{array}{lll} \text{Ex. Log.} & 437{\cdot}58 & = 2{\cdot}6410575 \\ \text{Log.} & 43{\cdot}758 & = 1{\cdot}6410575 \\ \text{Log.} & 4{\cdot}3758 & = 0{\cdot}6410575 \\ \text{Log.} & {\cdot}43758 & = \bar{1}{\cdot}6410575 \\ \text{Log.} & {\cdot}043758 & = \bar{2}{\cdot}6410575 \end{array}$$

Negative characteristics are calculated according to the ordinary rules of algebraic addition and subtraction. A few examples will show the methods employed.

(1) Addition—

$$\begin{array}{lr} \text{Add} & 5{\cdot}3468541 \\ & \bar{3}{\cdot}2685427 \\ \hline & 2{\cdot}6153968 \end{array}$$

+5 added to $\bar{3}$ gives +2.

$$\begin{array}{lr} \text{Add} & 6{\cdot}3874654 \\ & \bar{2}{\cdot}9245636 \\ \hline & 5{\cdot}3120290 \end{array}$$

+6 is increased to +7 by the 1 carried over from the mantissæ, and +7 added to $\bar{2}$ gives +5.

*The negative sign is placed *over* the characteristic to indicate that *it alone* is negative. If placed in front, like an ordinary negative sign, both characteristic and mantissa would become negative.

NOTES ON LOGARITHMS—*continued.*

(1) Addition—*continued.*

$$\begin{array}{r} \text{Add } \bar{2}\cdot5632874 \\ \bar{3}\cdot2465281 \\ \hline \bar{5}\cdot8098155 \end{array}$$

$$\begin{array}{r} \text{Add } \bar{3}\cdot3010300 \\ \bar{2}\cdot9020029 \\ \hline \bar{4}\cdot2030329 \end{array}$$

Here the $+1$ carried over from the mantissæ is added to $\bar{3}$ giving $\bar{2}$, and $\bar{2}$ added to $\bar{2}$ gives $\bar{4}$.

(2) Subtraction—

Rule.—Change the sign of the characteristic in the lower line, and add as above.

$$\begin{array}{lr} \text{From} & 2\cdot6847658 \\ \text{Subtract} & \bar{3}\cdot2468543 \\ \hline & 5\cdot4379115 \end{array}$$

$\bar{3}$ becomes, on changing its sign, $+3$, and this added to $+2$ gives $+5$.

$$\begin{array}{lr} \text{From} & \bar{2}\cdot3468537 \\ \text{Subtract} & \bar{5}\cdot7654626 \\ \hline & 2\cdot5813911 \end{array}$$

Here 1 is carried over from the mantissæ, and has to be subtracted from $\bar{2}$, giving $\bar{3}$: then changing the $\bar{5}$ into $+5$, and adding this to $\bar{3}$, we have $+2$.

$$\begin{array}{lr} \text{From} & \bar{5}\cdot6843252 \\ \text{Subtract} & \bar{3}\cdot7856310 \\ \hline & \bar{3}\cdot8986942 \end{array}$$

Here the 1 carried over subtracted from $\bar{5}$ gives $\bar{6}$; then changing $\bar{3}$ into $+3$ and adding it to $\bar{6}$, we have $\bar{3}$.

Proportional Parts.—When the logarithm of a number consisting of five figures or less is required, it can be found immediately in the tables; but if the numbers consist of more than five figures, a little calculation is required in order to find its correct logarithm. This calculation is greatly facilitated by the use of a *table of proportional parts.* It will be seen, on reference to the tables, that the differences between the logarithms of numbers differing by 1 in the fifth figure remain remarkably constant for a great many successive numbers, except at the beginning of the tables, where the changes are rather rapid. Thus, from 66500 to 67500 the difference between any two consecutive logarithms is uniformly 65: *e.g.*, log. 66511 (=4·8228935) subtracted from log. 66512 (=4·8229000) gives 65. Suppose, then, we require the logarithm of a number consisting of six or seven figures, as for instance 66511·37, how do we proceed to find it?

NOTES ON LOGARITHMS—*continued.*

This is done as follows :—First write down the next lower logarithm.

Log. 66511 = 4·8228935,

then, since the difference of 1 in the fifth figure makes a difference of 65 in the logarithm, a difference of ·37 will make a difference of 65 × ·37 = 24.

.·. Log. 66511·37 = 4·8228935 + 24 = 4·8228959.

In the *table of proportional parts*, however, the amount to be added for every tenth of a unit is recorded, and by this table the above result may be easily found thus :—

Log. 66511	= 4·8228035
Proportional part for ·3 =	20
Proportional part for ·07 =	46
	4·82289596

Conversely, the number to six, seven, or more figures corresponding to a given logarithm, is found by a method exactly the converse of that given above.

Example.—Find the number whose log. is 2·9324547.

2·9324547	
2·9324535 = log. 865·96	
12	
10 =	·002
20 =	·0004
	855·9624 the number required.

In the above example the difference between the given log. and the next lower in the tables being 12, the required number will evidently lie between 855·962 and 855·963, since the proportional part for 2 is 10 and that for 3 is 15. Subtracting that for 2, namely 10, we have 2 left. Annex a cipher to the 2, since the figure to be found will occupy the next decimal place, and the number 20 thus obtained is the proportional part for the figure 4.

COMMON LOGARITHMS.

	0	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
10	0	00432	00860	01284	01703	02119	02531	02938	03342	03743									
11	04139	04532	04922	05308	05690	06070	06446	06819	07188	07555									
12	07918	08279	08636	08991	09342	09691	10037	10380	10721	11059									
13	11394	11727	12057	12385	12710	13033	13354	13672	13988	14301									
14	14613	14922	15229	15534	15836	16137	16435	16732	17026	17319									
15	17609	17898	18184	18469	18752	19033	19312	19590	19866	20140									
16	20412	20683	20952	21219	21484	21748	22011	22272	22531	22789									
17	23045	23300	23553	23805	24055	24304	24551	24797	25042	25285									
18	25527	25768	26007	26245	26482	26717	26951	27184	27616	27646									
19	27875	28103	28330	28556	28780	29003	29226	29447	29667	29885									
20	30103	30320	30535	30750	30963	31175	31387	31597	31806	32015	21	42	64	85	106	127	148	170	191
21	32222	32428	32634	32838	33041	33244	33445	33646	33846	34044	20	40	61	81	101	121	141	162	182
22	34242	34439	34635	34830	35025	35218	35411	35603	35793	35984	19	39	58	77	97	116	135	154	174
23	36173	36361	36549	36736	36922	37107	37291	37475	37658	37840	18	37	55	74	92	111	129	148	166
24	38021	38202	38382	38561	38739	38917	39094	39270	39445	39620	18	35	53	71	89	106	124	142	160
25	39794	39967	40140	40312	40483	40654	40824	40993	41162	41330	17	34	51	68	85	102	119	136	153
26	41497	41664	41830	41996	42160	42325	42488	42651	42813	42975	16	33	49	66	82	98	115	131	148
27	43136	43297	43457	43616	43775	43933	44091	44248	44404	44560	16	32	47	63	79	95	111	126	142
28	44716	44871	45025	45179	45332	45484	45637	45788	45939	46090	15	30	46	61	76	91	107	122	137
29	46240	46389	46538	46687	46835	46982	47129	47276	47422	47567	15	29	44	59	74	88	103	118	132

COMMON LOGARITHMS—(*continued*).

	0	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
30	47712	47857	48001	48144	48287	48430	48572	48714	48855	48996	14	28	43	57	71	85	100	114	128
31	49136	49276	49415	49554	49693	49831	49969	50106	50243	50379	14	28	41	55	69	83	97	110	124
32	50515	50651	50786	50920	51055	51188	51322	51455	51587	51720	13	27	40	53	67	80	94	107	120
33	51851	51983	52114	52244	52375	52504	52634	52763	52892	53020	13	26	39	52	65	78	91	104	117
34	53148	53275	53403	53529	53656	53782	53908	54033	54158	54283	13	25	38	50	63	76	88	101	113
35	54407	54531	54654	54777	54900	55023	55145	55267	55388	55509	12	24	37	49	61	73	86	98	110
36	55630	55751	55871	55991	56110	56229	56348	56467	56585	56703	12	24	36	48	59	71	83	95	107
37	56820	56937	57054	57171	57287	57403	57519	57634	57749	57864	12	23	35	46	58	69	81	93	104
38	57978	58092	58206	58320	58433	58546	58659	58771	58883	58995	11	23	34	45	56	68	79	90	102
39	59106	59218	59329	59439	59550	59660	59770	59879	59988	60097	11	22	33	44	55	66	77	88	99
40	60206	60314	60423	60531	60638	60746	60853	60959	61066	61172	11	21	32	43	54	64	75	86	97
41	61278	61384	61490	61595	61700	61805	61909	62014	62118	62221	10	21	31	42	52	63	73	84	94
42	62325	62428	62531	62634	62737	62839	62941	63043	63144	63246	10	20	31	41	51	61	72	82	92
43	63347	63448	63548	63649	63749	63849	63949	64048	64147	64246	10	20	30	40	50	60	70	80	90
44	64345	64444	64542	64640	64738	64836	64933	65031	65128	65225	10	20	29	39	49	59	68	78	88
45	65321	65418	65514	65610	65706	65801	65896	65992	66087	66181	10	19	29	38	48	57	67	76	86
46	66276	66370	66464	66558	66652	66745	66839	66932	67025	67117	9	19	28	37	47	56	65	75	84
47	67210	67302	67394	67486	67578	67669	67761	67852	67943	68034	9	18	27	37	46	55	64	73	82
48	68124	68215	68305	68395	68485	68574	68664	68753	68842	68931	9	18	27	36	45	54	63	72	81
49	69020	69108	69197	69285	69373	69461	69548	69636	69723	69810	9	18	26	35	44	53	61	70	79

Note.—The tabular logs. of numbers 1 to 10 are the same as those of 10, 20, 30, etc.

COMMON LOGARITHMS—(*continued*).

	0	1	2	3	4	5	6	7	8	9	1 2 3	4 5 6	7 8 9
50	69897	69984	70070	70157	70243	70329	70415	70501	70586	70672	9 17 26	34 43 52	60 69 77
51	70757	70842	70927	71012	71096	71181	71265	71349	71433	71517	8 17 25	34 42 51	59 67 76
52	71600	71684	71767	71850	71933	72016	72099	72181	72263	72346	8 17 25	33 41 50	58 66 74
53	72428	72509	72591	72673	72754	72835	72916	72997	73078	73159	8 16 24	32 41 49	57 65 73
54	73239	73320	73400	73480	73560	73640	73719	73799	73878	73957	8 16 24	32 40 48	56 64 72
55	74036	74115	74194	74273	74351	74429	74507	74586	74663	74741	8 16 23	31 39 47	55 63 70
56	74819	74896	74974	75051	75128	75205	75282	75358	75435	75511	8 15 23	31 38 46	54 61 69
57	75587	75664	75740	75815	75891	75967	76042	76118	76193	76268	8 15 23	30 38 45	53 60 68
58	76343	76418	76492	76567	76641	76716	76790	76864	76938	77012	7 15 22	30 37 45	52 59 67
59	77085	77159	77232	77305	77379	77452	77525	77597	77670	77743	7 15 22	29 36 44	51 58 66
60	77815	77887	77960	78032	78104	78176	78247	78319	78390	78462	7 14 22	29 36 43	50 57 65
61	78533	78604	78675	78746	78817	78888	78958	79029	79099	79169	7 14 21	28 35 42	49 56 64
62	79239	79309	79379	79449	79518	79588	79657	79727	79796	79865	7 14 21	28 35 42	49 56 63
63	79934	80003	80072	80140	80209	80277	80346	80414	80482	80550	7 14 21	27 34 41	48 55 62
64	80618	80686	80754	80821	80889	80956	81023	81090	81158	81224	7 13 20	27 34 40	47 54 61
65	81291	81358	81425	81491	81558	81624	81690	81757	81823	81889	7 13 20	27 33 40	46 53 60
66	81954	82020	82086	82151	82217	82282	82347	82413	82478	82543	7 13 20	26 33 39	46 52 59
67	82607	82672	82737	82802	82866	82930	82995	83059	83123	83187	6 13 19	26 32 39	45 51 58
68	83251	83315	83378	83442	83506	83569	83632	83696	83759	83822	6 13 19	25 32 38	44 51 57
69	83885	83948	84011	84073	84136	84198	84261	84323	84386	84448	6 12 19	25 31 37	44 50 56

COMMON LOGARITHMS—(*continued*).

	0	1	2	3	4	5	6	7	8	9	1 2 3	4 5 6	7 8 9
70	84510	84572	84634	84696	84757	84819	84880	84942	85003	85065	6 12 18	25 31 37	43 49 55
71	85126	85187	85248	85309	85370	85431	85491	85552	85612	85673	6 12 18	24 30 36	43 49 55
72	85733	85794	85854	85914	85974	86034	86094	86153	86213	86273	6 12 18	24 30 36	42 48 54
73	86332	86392	86451	86510	86570	86629	86688	86747	86806	86864	6 12 18	24 30 35	41 47 53
74	86923	86982	87040	87099	87157	87216	87274	87332	87390	87448	6 12 17	23 29 35	41 47 52
75	87506	87564	87622	87679	87737	87795	87852	87910	87967	88024	6 12 17	23 29 35	40 46 52
76	88081	88138	88195	88252	88309	88366	88423	88480	88536	88593	6 11 17	23 28 34	40 45 51
77	88649	88705	88762	88818	88874	88930	88986	89042	89098	89154	6 11 17	22 28 34	39 45 50
78	89209	89265	89321	89376	89432	89487	89542	89597	89653	89708	6 11 17	22 28 33	39 44 50
79	89763	89818	89873	89927	89982	90037	90091	90146	90200	90255	5 11 16	22 27 33	38 44 49
80	90309	90363	90417	90472	90526	90580	90634	90687	90741	90795	5 11 16	22 27 32	38 43 49
81	90849	90902	90956	91009	91062	91116	91169	91222	91275	91328	5 11 16	21 27 32	37 43 48
82	91381	91434	91487	91540	91593	91645	91698	91751	91803	91855	5 11 16	21 26 32	37 42 47
83	91908	91960	92012	92065	92117	92169	92221	92273	92324	92376	5 10 16	21 26 31	36 42 47
84	92428	92480	92531	92583	92634	92686	92737	92788	92840	92891	5 10 15	21 26 31	36 41 46
85	92942	92993	93044	93095	93146	93197	93247	93298	93349	93399	5 10 15	20 25 30	36 41 46
86	93450	93500	93551	93601	93651	93702	93752	93802	93852	93902	5 10 15	20 25 30	35 40 45
87	93952	94002	94052	94101	94151	94201	94250	94300	94349	94399	5 10 15	20 25 30	35 40 45
88	94448	94498	94547	94596	94645	94694	94743	94792	94841	94890	5 10 15	20 25 29	34 39 44
89	94939	94988	95036	95085	95134	95182	95231	95279	95328	95376	5 10 15	19 24 29	34 39 44

COMMON LOGARITHMS—*(continued).*

	0	1	2	3	4	5	6	7	8	9	1 2 3	4 5 6	7 8 9
90	95424	95472	95521	95569	95617	95665	95713	95761	95809	95856	5 10 14	19 24 29	34 38 43
91	95904	95952	95999	96047	96095	96142	96190	96237	96284	96332	5 9 14	19 24 28	33 38 43
92	96379	96426	96473	96520	96567	96614	96661	96708	96755	96802	5 9 14	19 23 28	33 38 42
93	96848	96895	96942	96988	97035	97081	97128	97174	97220	97267	5 9 14	19 23 28	33 37 42
94	97313	97359	97405	97451	97497	97543	97589	97635	97681	97727	5 9 14	18 23 28	32 37 41
95	97772	97818	97864	97909	97955	98000	98046	98091	98137	98182	5 9 14	18 23 27	32 36 41
96	98227	98272	98318	98363	98408	98453	98498	98543	98588	98632	5 9 14	18 23 27	32 36 41
97	98677	98722	98767	98811	98856	98900	98945	98989	99034	99078	4 9 13	18 22 27	31 36 40
98	99123	99167	99211	99255	99300	99344	99388	99432	99476	99520	4 9 13	18 22 26	31 35 40
99	99564	99607	99651	99695	99739	99782	99826	99870	99913	99957	4 9 13	17 22 26	31 35 39
100	0	00043	00087	00130	00173	00217	00260	00303	00346	00389	4 9 13	17 22 26	30 35 39
101	00432	00475	00518	00561	00604	00647	00689	00732	00775	00817	4 9 13	17 21 26	30 34 39
102	00860	00903	00945	00988	01030	01072	01115	01157	01199	01242	4 8 13	17 21 25	30 34 38
103	01284	01326	01368	01410	01452	01494	01536	01578	01620	01662	4 8 13	17 21 25	29 34 38
104	01703	01745	01787	01828	01870	01912	01953	01995	02036	02078	4 8 12	17 21 25	29 33 37
105	02119	02160	02202	02243	02284	02325	02366	02407	02449	02490	4 8 12	16 21 25	29 33 37
106	02531	02572	02612	02653	02694	02735	02776	02816	02857	02898	4 8 12	16 20 24	29 33 37
107	02938	02979	03019	03060	03100	03141	03181	03222	03262	03302	4 8 12	16 20 24	28 32 36
108	03342	03383	03423	03463	03503	03543	03583	03623	03663	03703	4 8 12	16 20 24	28 32 36
109	03743	03782	03822	03862	03902	03941	03981	04021	04060	04100	4 8 12	16 20 24	28 32 36

COMMON LOGARITHMS—*(continued).*

	0	1	2	3	4	5	6	7	8	9	1 2 3	4 5 6	7 8 9
110	04139	04179	04218	04258	04297	04336	04376	04415	04454	04493	4 8 12	16 20 24	28 31 35
111	04532	04571	04610	04650	04689	04727	04766	04805	04844	04883	4 8 12	16 19 23	27 31 35
112	04922	04961	04999	05038	05077	05115	05154	05192	05231	05269	4 8 12	15 19 23	27 31 35
113	05308	05346	05385	05423	05461	05500	05538	05576	05614	05652	4 8 11	15 19 23	27 31 34
114	05690	05729	05767	05805	05843	05881	05918	05956	05994	06032	4 8 11	15 19 23	27 30 34
115	06070	06108	06145	06183	06221	06258	06296	06333	06371	06408	4 8 11	15 19 23	26 30 34
116	06446	06483	06521	06558	06595	06633	06670	06707	06744	06781	4 7 11	15 19 22	26 30 34
117	06819	06856	06893	06930	06967	07004	07041	07078	07115	07151	4 7 11	15 18 22	26 30 33
118	07188	07225	07262	07298	07335	07372	07408	07445	07482	07518	4 7 11	15 18 22	26 29 33
119	07555	07591	07628	07664	07700	07737	07773	07809	07846	07882	4 7 11	15 18 22	25 29 33
120	07918	07954	07990	08027	08063	08099	08135	08171	08207	08243	4 7 11	14 18 22	25 29 32
121	08279	08314	08350	08386	08422	08458	08493	08529	08565	08600	4 7 11	14 18 21	25 29 32
122	08636	08672	08707	08743	08778	08814	08849	08884	08920	08955	4 7 11	14 18 21	25 28 32
123	08991	09026	09061	09096	09132	09167	09202	09237	09272	09307	4 7 11	14 18 21	25 28 32
124	09342	09377	09412	09447	09482	09517	09552	09587	09621	09656	3 7 10	14 17 21	24 28 31
125	09691	09726	09760	09795	09830	09864	09899	09934	09968	10003	3 7 10	14 17 21	24 28 31
126	10037	10072	10106	10140	10175	10209	10243	10278	10312	10346	3 7 10	14 17 21	24 27 31
127	10380	10415	10449	10483	10517	10551	10585	10619	10653	10687	3 7 10	14 17 20	24 27 31
128	10721	10755	10789	10823	10857	10890	10924	10958	10992	11025	3 7 10	14 17 20	24 27 30
129	11059	11093	11126	11160	11193	11227	11261	11294	11327	11361	3 7 10	13 17 20	23 27 30

COMMON LOGARITHMS—(*continued*).

	0	1	2	3	4	5	6	7	8	9	1 2 3	4 5 6	7 8 9
130	11394	11428	11461	11494	11528	11561	11594	11628	11661	11694	3 7 10	13 17 20	23 27 30
131	11727	11760	11793	11826	11860	11893	11926	11959	11992	12024	3 7 10	13 17 20	23 26 30
132	12057	12090	12123	12156	12189	12222	12254	12287	12320	12352	3 7 10	13 16 20	23 26 29
133	12385	12418	12450	12483	12516	12548	12581	12613	12646	12678	3 7 10	13 16 20	23 26 39
134	12710	12743	12775	12808	12840	12872	12905	12937	12969	13001	3 6 10	13 16 19	23 26 29
135	13033	13066	13098	13130	13162	13194	13226	13258	13290	13322	3 6 10	13 16 19	22 26 29
136	13354	13386	13418	13450	13481	13513	13545	13577	13609	13640	3 6 10	13 16 19	22 25 29
137	13672	13704	13735	13767	13799	13830	13862	13893	13925	13956	3 6 9	13 16 19	22 25 28
138	13988	14019	14051	14082	14114	14145	14176	14208	14239	14270	3 6 9	13 16 19	22 25 28
139	14301	14333	14364	14395	14426	14457	14489	14520	14551	14582	3 6 9	12 16 19	22 25 28
140	14613	14644	14675	14706	14737	14768	14799	14829	14860	14891	3 6 9	12 15 19	22 25 28
141	14922	14953	14983	15014	15045	15076	15106	15137	15168	15198	3 6 9	12 15 18	21 25 28
142	15229	15259	15290	15320	15351	15381	15412	15442	15473	15503	3 6 9	12 15 18	21 24 27
143	15534	15564	15594	15625	15655	15685	15715	15746	15776	15806	3 6 9	12 15 18	21 24 27
144	15836	15866	15897	15927	15957	15987	16017	16047	16077	16107	3 6 9	12 15 18	21 24 27
145	16137	16167	16197	16227	16256	16286	16316	16346	16376	16406	3 6 9	12 15 18	21 24 27
146	16435	16465	16495	16524	16554	16584	16613	16643	16673	16702	3 6 9	12 15 18	21 24 27
147	16732	16761	16791	16820	16850	16879	16909	16938	16967	16997	3 6 9	12 15 18	21 24 26
148	17026	17056	17085	17114	17143	17173	17202	17231	17260	17289	3 6 9	12 15 18	20 23 26
149	17319	17348	17377	17406	17435	17464	17493	17522	17551	17580	3 6 9	12 15 17	20 23 26

COMMON LOGARITHMS—(*continued*).

	0	1	2	3	4	5	6	7	8	9	1 2 3	4 5 6	7 8 9
150	17609	17638	17667	17696	17725	17754	17782	17811	17840	17869	3 6 9	12 14 17	20 23 26
151	17898	17926	17955	17984	18013	18041	18070	18099	18127	18156	3 6 9	11 14 17	20 23 26
152	18184	18213	18241	18270	18298	18327	18355	18384	18412	18441	3 6 9	11 14 17	20 23 26
153	18469	18498	18526	18554	18583	18611	18639	18667	18696	18724	3 6 8	11 14 17	20 23 25
154	18752	18780	18808	18837	18865	18893	18921	18949	18977	19005	3 6 8	11 14 17	20 22 25
155	19033	19061	19089	19117	19145	19173	19201	19229	19257	19285	3 6 8	11 14 17	20 22 25
156	19312	19340	19368	19396	19424	19451	19479	19507	19535	19562	3 6 8	11 14 17	19 22 25
157	19590	19618	19645	19673	19700	19728	19756	19783	19811	19838	3 6 8	11 14 17	19 22 25
158	19866	19893	19921	19948	19976	20003	20030	20058	20085	20112	3 5 8	11 14 16	19 22 25
159	20140	20167	20194	20222	20249	20276	20303	20330	20358	20385	3 5 8	11 14 16	19 22 25
160	20412	20439	20466	20493	20520	20548	20575	20602	20629	20656	3 5 8	11 14 16	19 22 24
161	20683	20710	20737	20763	20790	20817	20844	20871	20898	20925	3 5 8	11 13 16	19 22 24
162	20952	20978	21005	21032	21059	21085	21112	21139	21165	21192	3 5 8	11 13 16	19 21 24
163	21219	21245	21272	21299	21325	21352	21378	21405	21431	21458	3 5 8	11 13 16	19 21 24
164	21484	21511	21537	21564	21590	21617	21643	21669	21696	21722	3 5 8	11 13 16	18 21 24
165	21748	21775	21801	21827	21854	21880	21906	21932	21958	21985	3 5 8	10 13 16	18 21 24
166	22011	22037	22063	22089	22115	22141	22167	22194	22220	22246	3 5 8	10 13 16	18 21 23
167	22272	22298	22324	22350	22376	22401	22427	22453	22479	22505	3 5 8	10 13 16	18 21 23
168	22531	22557	22583	22608	22634	22660	22686	22712	22737	22763	3 5 8	10 13 15	18 21 23
169	22789	22814	22840	22866	22891	22917	22943	22968	22994	23019	3 5 8	10 13 15	18 20 23

COMMON LOGARITHMS.—*(continued).*

	0	1	2	3	4	5	6	7	8	9	1 2 3	4 5 6	7 8 9
170	23045	23070	23096	23121	23147	23172	23198	23223	23249	23274	3 5 8	10 13 15	18 20 23
171	23300	23325	23350	23376	23401	23426	23452	23477	23502	23528	3 5 8	10 13 15	18 20 23
172	23553	23578	23603	23629	23654	23679	23704	23729	23754	23779	3 5 8	10 13 15	18 20 23
173	23805	23830	23855	23880	23905	23930	23955	23980	24005	24030	3 5 8	10 13 15	18 20 23
174	24055	24080	24105	24130	24155	24180	24204	24229	24254	24279	2 5 7	10 12 15	17 20 22
175	24304	24329	24353	24378	24403	24428	24452	24477	24502	24527	2 5 7	10 12 15	17 20 22
176	24551	24576	24601	24625	24650	24674	24699	24724	24748	24773	2 5 7	10 12 15	17 20 22
177	24797	24822	24846	24871	24895	24920	24944	24969	24993	25018	2 5 7	10 12 15	17 20 22
178	25042	25066	25091	25115	25139	25164	25188	25212	25237	25261	2 5 7	10 12 15	17 19 22
179	25285	25310	25334	25358	25382	25406	25431	25455	25479	25503	2 5 7	10 12 15	17 19 22
180	25527	25551	25575	25600	25624	25648	25672	25696	25720	25744	2 5 7	10 12 14	17 19 22
181	25768	25792	25816	25840	25864	25888	25912	25935	25959	25983	2 5 7	9 12 14	17 19 22
182	26007	26031	26055	26079	26102	26126	26150	26174	26198	26221	2 5 7	9 12 14	17 19 21
183	26245	26269	26293	26316	26340	26364	26387	26411	26435	26458	2 5 7	9 12 14	17 19 21
184	26482	26505	26529	26553	26576	26600	26623	26647	26670	26694	2 5 7	9 12 14	16 19 21
185	26717	26741	26764	26788	26811	26834	26858	26881	26905	26928	2 5 7	9 12 14	16 19 21
186	26951	26975	26998	27021	27045	27068	27091	27114	27138	27161	2 5 7	9 12 14	16 19 21
187	27184	27207	27231	27254	27277	27300	27323	27346	27370	27393	2 5 7	9 12 14	16 19 21
188	27416	27439	27462	27485	27508	27531	27554	27577	27600	27623	2 5 7	9 12 14	16 18 21
189	27646	27669	27692	27715	27738	27761	27784	27807	27830	27852	2 5 7	9 11 14	16 18 21

COMMON LOGARITHMS—*(continued).*

	0	1	2	3	4	5	6	7	8	9	1 2 3	4 5 6	7 8 9
190	27875	27898	27921	27944	27967	27989	28012	28035	28058	28081	2 5 7	9 11 14	16 18 21
191	28103	28126	28149	28171	28194	28217	28240	28262	28285	28307	2 5 7	9 11 14	16 18 20
192	28320	28353	28375	28398	28421	28443	28466	28488	28511	28533	2 5 7	9 11 14	16 18 20
193	28556	28578	28601	28623	28646	28668	28691	28713	28735	28758	2 4 7	9 11 13	16 18 20
194	28780	28803	28825	28847	28870	28892	28914	28937	28959	28981	2 4 7	9 11 13	16 18 20
195	29003	29026	29048	29070	29092	29115	29137	29159	29181	29203	2 4 7	9 11 13	16 18 20
196	29226	29248	29270	29292	29314	29336	29358	29380	29403	29425	2 4 7	9 11 13	15 18 20
197	29447	29469	29491	29513	29535	29557	29579	29601	29623	29645	2 4 7	9 11 13	15 18 20
198	29667	29688	29710	29732	29754	29776	29798	29820	29842	29863	2 4 7	9 11 13	15 18 20
199	29885	29907	29929	29951	29973	29994	30016	30038	30060	30081	2 4 7	9 11 13	15 17 20

Base of Common Logarithms = 10. Hyp. Log. $z = \frac{1}{M}$ Com. Log. z.	Base of Hyperbolic Logarithms $= \epsilon = 2{\cdot}71828$. Com. Log. z = M Hyp. Log. z.

Number.	Com. Log.	Number.	Com. Log.
$\epsilon = 2{\cdot}71828$	0·434 2945	$\pi = 3{\cdot}14159$	0·497 1499
$\frac{1}{M} = 2{\cdot}30259$	0·362 2157	$\frac{\pi}{4} = 0{\cdot}785398$	$\bar{1}$·895 0899
$M = 0{\cdot}434294$	$\bar{1}$·637 7843	$\frac{\pi}{6} = 0{\cdot}52359$	$\bar{1}$·718 9986
		$\sqrt{\pi} = 1{\cdot}77245$	0·248 5749

VARIOUS USEFUL FACTORS.

To convert :—	Multiplier.	Logarithm.
Grams per litre into grains per cubic foot	437·00	2·640 4762
,, ,, ounces (av.) ,,	0·99884	$\bar{1}$·999 4981
,, ,, lb. ,,	0·06243	$\bar{2}$·795 3781
,, ,, grains per fluid oz.	0·43847	$\bar{1}$·641 9391
,, ,, grains per gallon	70·155	1·846 0591
Grains per gallon into cwts. per million gallons	1·2755	0·105 6839
,, ,, grams per litre ...	0·014254	$\bar{2}$·153 9409
Percentage into grains per fluid oz. ...	4·375	0·640 9781
Litres into cubic feet	0·035315	$\bar{2}$·547 9562
1 kilogrammetre = 7·2331 foot-pounds ...	... ...	0·859 3196
1 foot-pound = 0·13825 kilogrammetres	... ...	$\bar{1}$·140 6804

WEIGHTS AND MEASURES.

I. Imperial System.

Avoirdupois Weight.

16 drams	=1 ounce (oz.)=437·5 grains*	log. 437·5=2·640 9781
16 ounces	=1 pound (lb.)=7000 ,,	log. 7000 =3·845 0980
14 pounds	=1 stone	
28 pounds	=1 quarter (qr.)	
4 quarters	=1 hundredweight (cwt.)=112 lbs.	log. 112=2·049 2180
20 cwt.	=1 ton =2240 lbs.	log. 2240=3·350 2480

1 dram (avoirdupois)=27·34375 grains (log. 1·436 8581).

Troy Weight..

24 grains*	=1 pennyweight (dwt.)	
20 pennyweights	=1 ounce (oz.)=480 grains	log. 480=2·681 2412
12 ounces	=1 pound (lb.)=5760 ,,	log. 5760=3·760 4225

	Multiplier.	Logarithms.
To convert lbs. avoirdupois into lbs. troy	1·2153	0·084 6755
,, lbs. troy into lbs. avoirdupois	0·82286	$\bar{1}$·915 3245

Apothecaries' Weight.

20 grains (gr.)	=1 scruple (℈)
3 scruples or 60 grains	=1 drachm (ʒ).
8 drachms or 480 grains	=1 ounce (℥)
12 ounces or 5760 grains	=1 pound (lb.)

Apothecaries' Measures.

60 minims (min.)	=1 fluid drachm (fl. dr. or *f* ʒ).
8 fluid drachms	=1 fluid ounce (fl. oz. or *f* ℥).
20 fluid ounces	=1 pint (O) †
8 pints	=1 gallon (C) ‡

Relations of Apothecaries' Measures to Weights.

(All liquids to be measured at 60° Fah.)

		Logarithms.
1 minim is the measure of	0·91 grain weight of water	$\bar{1}$·959 0414
1 fluid drachm ,,	54·68 grains ,,	1·737 8285
1 fluid ounce ,,	437·5 ,, ,,	2·640 9781
1 pint ,,	1·25 pounds ,,	0·096 9100
,, ,,	8750 grains ,,	3·942 0081
1 gallon ,,	70,000 § ,, ,,	4·845 0980
1 pint = 34·6829 cubic inches	... ...	1·540 1149
1 gallon=277·463 ,,	... ...	2·443 2049
1 gallon=0·16057 cubic foot	... ...	$\bar{1}$·205 6612
To convert cubic inches into pints	multiply by 0·02883	$\bar{2}$·459 8851
,, ,, gallons	,, 0·003604	$\bar{3}$·556 7951
,, cubic feet into gallons	,, 6·228	0·794 3388

* The grain is common to both Avoirdupois and Troy Weights.

† O=octarius, *i.e.*, one-eighth. ‡ C=(Roman) Congius.

§ According to H. J. Chaney

One gallon once distilled water weighs 70000·5 grains.

,, twice ,, ,, 70000·0 ,,

,, well water weighs 70066·6 ,,

WEIGHTS AND MEASURES—*continued.*

Long Measure.

12 lines	=	1 inch
12 inches	=	1 foot
3 feet	=	1 yard
6 feet	=	1 fathom
$5\frac{1}{2}$ yards	=	1 rod, pole, or perch
4 poles	=	1 chain
40 poles	=	1 furlong
8 furlongs	=	1 mile = 1760 yards

Square Measure.

144	square inches	= 1	square foot
9	,, feet	= 1	,, yard
$30\frac{1}{4}$	,, yards	= 1	,, rod, pole, or perch
40	,, poles	= 1	rood
	4 roods	= 1	acre = 4840 square yards
	640 acres	= 1	mile

Cubic or Solid Measure.

1728 cubic inches = 1 cubic foot	log. 1728 = 3·237 5437
27 ,, feet = 1 ,, yard	log. 27 = 1·431 3638

		Logarithms.
1 cubic inch of water* at 62° Fahr. weighs	252·286 grains	2·401 8931
,, ,, ,,	0·57665 ozs. (av.)	$\bar{1}$·760 9150
,, ,, ,,	0·036041 lbs. ,,	$\bar{2}$·556 7951
1 cubic foot ,, ,,	996·458 ozs. ,,	2·998 4587
,, ,, ,,	62·2786 lbs. ,,	1·794 3388
,, ,, ,,	28·2491 kilograms	1·451 0046
1 cubic yard ,, ,,	0·75068 tons	$\bar{1}$·875 4546

Wine and Spirit Measure.

4 gills	=	1 pint
2 pints	=	1 quart
4 quarts	=	1 gallon
63 gallons	=	1 hogshead
84 gallons	=	1 puncheon
2 hogsheads	=	1 pipe or butt = 126 gallons
4 hogsheads	=	1 tun = 252 gallons

Ale, Beer, and Porter Measure.

4 gills	=	1 pint	
2 pints	=	1 quart	
4 quarts	=	1 gallon	
9 gallons	=	1 firkin	
2 firkins	=	1 kilderkin	= 18 gallons
2 kilderkins	=	1 barrel	= 36 ,,
3 ,,	=	1 hogshead	= 54 ,,
3 hogsheads	=	1 butt	= 108 ,,

* *i.e.*, distilled water freed from air.

WEIGHTS AND MEASURES—*continued.*

Dry Measure.

4 gills	=1 pint
2 pints	=1 quart
4 quarts	=1 gallon
2 gallons	=1 peck
4 pecks	=1 bushel
8 bushels	=1 quarter
4 quarters	=1 chaldron
5 ,,	=1 weigh or horse-load
2 weighs	=1 last

II. WEIGHTS AND MEASURES OF THE METRIC SYSTEM.

Weights.

1 milligram	=the thousandth part of one gram or	0·001 gram
1 centigram	=the hundredth ,, ,,	0·01 ,,
1 decigram	=the tenth ,, ,,	0·1 ,,
1 gram	=the weight of a cubic centimetre of water at 4° C.	1·0 ,,
1 decagram	=ten grams	10·0 ,,
1 hectogram	=one hundred grams	100·0 ,,
1 kilogram	=one thousand ,,	1000·0 ,,

Measures of Capacity.

1 millilitre =	1 cubic centimetre	or the measure of	1 gram	of water
1 centilitre =	10 ,,	,,	10 grams	,,
1 decilitre =	100 ,,	,,	100 ,,	,,
1 litre =	1000 ,,	,,	1000 ,,	,,

Measures of Length.

1 millimetre	=the thousandth part of one metre or	0·001 metre
1 centimetre	=the hundredth ,,	0·01 ,,
1 decimetre	=the tenth ,,	0·1 ,,
1 metre	=the ten-millionth part of a quarter of the meridian of the earth	

TABLES FOR THE CONVERSION OF METRIC INTO IMPERIAL MEASURES AND *vice versa*.

A. *Linear Measure.*

Metric into Imperial.		Logarithms.
1 millimetre (mm.)	= 0·0393701 inches	$\bar{2}$·595 1666
1 centimetre (cm.)	= 0·393701 ,, ...	$\bar{1}$·595 1666
1 decimetre (dm.)	= 3·937011 ,, ...	0·595 1666
1 metre (m.)	=39·370113 ,, ...	1·595 1666
,,	= 3·280843 feet	0·515 9855
,,	= 1·093614 yards	0·038 8642
1 kilometre (km.)	= 1093·61426 ,, ...	3·038 8642
,,	= 0·621372 mile	$\bar{1}$·793 3515

*** 33 cm. = 13 inches, correct to 1 part in 1630.

Note.—A *micron* (denoted by μ) is one-thousandth of a millimetre (or nearly 0·00004 inch).

WEIGHTS AND MEASURES—*continued.*

Imperial into Metric.		Logarithms.
1 inch =	2·5399978 centimetres	0·404 8333
1 foot =	30·47997 ,, ...	1·484 0146
1 yard =	0·9143992 metre	$\bar{1}$·961 1359
1 mile =	1·6093426 kilometres	0·206 6484

*** 13 inches = 33 centimetres, correct to 1 part in 1630.

mm. Inches.	Metres. Feet.	Inches. mm.	Feet. Metres.
1 = ·03937	1 = 3·2808	1 = 25·4	1 = 0·3048
2 = ·07874	2 = 6·5616	2 = 50·8	2 = 0·6096
3 = ·11811	3 = 9·8424	3 = 76·2	3 = 0·9144
4 = ·15748	4 = 13·1232	4 = 101·6	4 = 1·2192
5 = ·19685	5 = 16·4040	5 = 127·0	5 = 1·5240
6 = ·23622	6 = 19·6848	6 = 152·4	6 = 1 8288
7 = ·27559	7 = 22·9656	7 = 177·8	7 = 2·1336
8 = ·31496	8 = 26·2464	8 = 203·2	8 = 2·4384
9 = ·35433	9 = 29·5272	9 = 228·6	9 = 2·7432

B. *Square Measure.*

Metric into Imperial.		Logarithms.
1 square decimetre (dm^2.)	= 15·50006 square inches	1·190 3333
1 square metre (m^2.) or centiare	= 10·76393 square feet ...	1·031 9708
,, ,,	= 1·195992 square yards	0·077 7283
1 are (100 square metres)	= 119·59921	2·077 7283
,, ,,	= 0·0247106 acres ..	$\bar{2}$·392 8833

Imperial into Metric.		
1 square inch	= 6·451589 square centimetres	0·809 6667
1 square foot	= 9·29029 square decimetres	0·968 0293
1 square yard	= 0·836126 square metres	$\bar{1}$·922 2717
1 acre	= 0·40468 hectare	$\bar{1}$·607 1117

C. *Cubic Measure and Measures of Capacity.*

Metric into Imperial, etc.		
1 cubic centimetre* (c.c.)	= 0·061024 cubic inches ...	$\bar{2}$·785 5000
,,	= 16·891 minims	1·227 6564
,,	= 0·28152 fluid drachms ...	$\bar{1}$·449 5051
,,	= 0·03519 fluid ounce	$\bar{2}$·546 4151
1 litre	= 61·0349 cubic inches	1·785 5782
,,	= 35·1960 fluid ounces	1·546 4933
,,	= 1·75980 pints	0·245 4633
,,	= 0·219975 gallons	$\bar{1}$·342 3733
1 cubic metre (m^3.)	= 35·31476 cubic feet	1·547 9562
,,	= 1·307954 cubic yards	0·116 5924

* The standard litre is the volume of a kilogram of pure water at 4° C. It was originally intended to be a cubic decimetre, but is actually somewhat greater. Hence parts of a litre—decilitre, centilitre and millilitre (ml.)—are not strictly equivalent to 100, 10 and 1 c.c. respectively.

Weights and Measures—*continued.*

c.c.	Cubic Inches.
1	0·061024
2	0·122048
3	0·183072
4	0·244096
5	0·305120
6	0·366144
7	0·427168
8	0·488192
9	0·549216

Litres.	Fluid Ounces.	Pints.	Gallons.
1	35·1960	1·7598	0·22000
2	70·3920	3·5196	0·43995
3	105·5880	5·2794	0·65993
4	140·7840	7·0392	0·87990
5	175·9800	8·7990	1·09988
6	211·1760	10·5588	1·31985
7	246·3720	12·3186	1·53983
8	281·5680	14·0784	1·75980
9	316·7640	15·8382	1·97978

Imperial into Metric.		Logarithms.
1 cubic inch	= 16·38702 cubic centimetres	1·214 5000
1 cubic foot	= 28·31677 cubic decimetres	1·452 0437
1 cubic yard	= 0·76455285 cubic metre	$\bar{1}$·883 4075
1 minim	= 0·05919 cubic centimetres	$\bar{2}$·772 2483
1 fluid drachm	= 3·55153 cubic centimetres	0·550 4155
1 fluid ounce	= 28·4123 cubic centimetres	1·453 5064
1 pint	= 568·25 cubic centimetres	2·754 5394
1 quart	= 1·13649 litres	0·055 5656
1 gallon	= 4·5459631 litres	0·657 6260

Cubic Inches.	Cubic Centimetres.
1	16·387
2	32·774
3	49·161
4	65·548
5	81·935
6	98·322
7	114·709
8	131·096
9	147·483

Fluid Ounces.	Cubic Centimetres.
1	28·4123
2	56·8246
3	85·2369
4	113·6492
5	142·0615
6	170·4738
7	198·8861
8	227·2984
9	255·7107

Pints.	Litres.
1	0·56825
2	1·13650
3	1·70475
4	2·27300
5	2·84125
6	3·40950
7	3·97775
8	4·54600
9	5·11425

Gallons.	Litres.
1	4 54596
2	9·09192
3	13·63788
4	18·18384
5	22·72980
6	27·27576
7	31·82172
8	36·36768
9	40·91364

Weights and Measures—*continued.*

Metric into Imperial.			Logarithms.
1 milligram	=	0·01543 grain	$\bar{2}$·188 4324
1 centigram	=	0·15432 grain	$\bar{1}$·188 4324
1 decigram	=	1·54324 grains	0·188 4324
1 gram	=	15·43236 grains	1·188 4324
,,	=	0·564383 dram avoirdupois ...	$\bar{1}$·751 5739
,,	=	0·035274 ounce avoirdupois ...	$\bar{2}$·547 4547
,,	=	0·25721 drachm	$\bar{1}$·410 2878
,,	=	0·0321507 ounce troy	$\bar{2}$·507 1905
1 kilogram	=	15432·35639 grains	4·188 4324
,,	=	35·2740 ounces avoirdupois ...	1·547 4547
,,	=	2·2046223 lbs. avoirdupois ...	0·343 3341
,,	=	32·15074 ounces troy	1·507 1910
,,	=	2·67923 lbs. troy	0·428 0100

Grams.	Grains.	Ozs. (Av.).	Ozs. (Troy).
1 =	15·43236 =	0·035274 =	0·0321507
2 =	30·86472 =	0·070548 =	0·0643014
3 =	46·29708 =	0·105822 =	0·0964521
4 =	61·72944 =	0·141096 =	0·1286028
5 =	77·16180 =	0·176370 =	0·1607535
6 =	92·59416 =	0·211644 =	0·1929042
7 =	108·02652 =	0·246918 =	0·2250549
8 =	123·45888 =	0·282192 =	0·2572056
9 =	138·89124 =	0·317466 =	0·2893563

Kilograms.	Pounds.
1 =	2·20462
2 =	4·40924
3 =	6·61386
4 =	8·81848
5 =	11·02310
6 =	13·22772
7 =	15·43234
8 =	17·63696
9 =	19·84158

Imperial into Metric.			Logarithms.
1 grain	=	0·064799 gram	2·811 5683
1 drachm	=	3·88794 grams	0·589 7196
1 ounce troy	=	31·10348 grams	1·492 8090
1 pound troy	=	373·24176 grams	2·571 9903
1 dram avoirdupois	=	1·77185 grams	0·248 4270
1 ounce avoirdupois	=	28·34953 grams	1·452 5459
1 pound avoirdupois	=	453·59243 grams	2·656 6658
1 stone (14 lbs.)	=	6·35029 kilograms ...	0·802 7935
1 quarter (28 lbs.)	=	12·70059 kilograms ...	1·103 8240
1 cwt.	=	50·80235 kilograms ...	1·705 8838
1 ton	=	1016·04704 kilograms ...	3·006 9138

Grains.	Grams.
1 =	0·06480
2 =	0·12960
3 =	0·19440
4 =	0·25920
5 =	0·32399
6 =	0·38879
7 =	0·45359
8 =	0·51839
9 =	0·58319

Ounces. (Av.)	Grams.
1 =	28·3495
2 =	56·6990
3 =	85·0485
4 =	113·3980
5 =	141·7475
6 =	170·0970
7 =	198·4465
8 =	226·7960
9 =	255·1455

Weights and Measures—*continued.*

Pounds to Kilograms.	Hundredweights to Kilograms.
1 = 0·45359	1 = 50·8024
2 = 0·90718	2 = 101·6048
3 = 1·36077	3 = 152·4072
4 = 1·81436	4 = 203·2096
5 = 2·26795	5 = 254·0120
6 = 2·72154	6 = 304·8144
7 = 3·17513	7 = 355·6168
8 = 3·62872	8 = 406·4192
9 = 4·08231	9 = 457·2216

Table showing the Signs used in writing Medical Prescriptions.

½ grain	½ gr.	1 drachm	ʒ i, or ʒ j.
1 ,, ...	gr. j, or gr. i.	1½ ,, ...	ʒ iss.
1½ ,, ...	gr. iss.	2 drachms	ʒ ii, or ʒ ij.
2 grains	gr. ii, or gr. ij.	3 ,, ...	ʒ iii, or ʒ iij.
2½ ,, ...	gr. iiss.	3½ ,, ...	ʒ iiiss.
4 ,, ...	gr. iv.	7½ ,, ...	ʒ viiss.
8 ,, ...	gr. viii, or gr. viij.	½ ounce	℥ ss.
½ scruple ..	℈ ss.	1 ,, ...	℥ i, or ℥ j.
1 ,, ..	℈ i, or ℈ j.	1½ ,, ...	℥ iss.
1½ ,, ..	℈ iss.	½ pint	Oss.
2 scruples ..	℈ ii, or ℈ ij	1 ,, ...	O.

Useful Data.

			Logarithms.
I. *Areas and Volumes of Bodies.*			
Area of a circle	$=\pi r^2$	r = radius	
		$\pi = 3·1415926$	0·497 1499
Volume of a sphere	$=\frac{4}{3}\pi r^3$	$\frac{4}{3}\pi = 4·1888$	0·622 0886
Volume of a cylinder	$=\pi r^2 h$	r = radius of a base	
		h = height	
Surface of sphere	$=4\pi r^2$	$4\pi = 12·5664$	1·099 2099

II. *Specific Gravity.*

To convert—

(1) Degrees of Twaddle's hydrometer into sp. gr. (water = 1000)—multiply by 5 and add 1000

(2) Sp. gr. (water = 1000) into degrees of Twaddle's hydrometer—subtract 1000 and divide by 5

(3) Sp. gr. (air = 1) to sp. gr. (H = 1)—multiply by 14·438 — Logarithm: 1·159 5070

(4) Sp. gr. (H = 1) to sp. gr. (air = 1)—multiply by 0·06926 — Logarithm: $\bar{2}$·840 4825

USEFUL DATA—*continued.*

III. *Various useful Factors.*

To convert—	Logarithms.
(1) Grams per litre into grains per gallon—multiply by 70	1·845 0980
(2) Grains per gallon into grams per litre—multiply by 0·014286	$\bar{2}$·154 9020
(3) Parts per 100,000 into grains per gallon—multiply by 0·7	$\bar{1}$·845 0980
(4) Grains per gallon into parts per 100,000—divide by 0·7	$\bar{1}$·845 0980
(5) Grams per fluid drachm into grains per fluid ounce—multiply by 123·46	2·091 5221

TABLE FOR THE CONVERSION OF PERCENTAGE INTO CWTS., QRS., AND LB. PER TON, AND INTO QRS. AND LB. PER CWT.

Per cent.	Per ton.			Per cwt.		Per cent.	Per ton.			Per cwt.	
	cwt.	qrs.	lb.	qrs.	lb.		cwt.	qrs.	lb.	qrs.	lb.
1	...	...	22·4	...	1·12	26	5	...	22·4	1	1·12
2	...	1	16·8	...	2·24	27	5	1	16·8	1	2·24
3	...	2	11·2	...	3·36	28	5	2	11·2	1	3·36
4	...	3	5·6	...	4·48	29	5	3	5·6	1	4·48
5	1	...	...	...	5·60	30	6	...	...	1	5·60
6	1	...	22·4	...	6·72	31	6	...	22·4	1	6·72
7	1	1	16·8	...	7·84	32	6	1	16·8	1	7·84
8	1	2	11·2	...	8·96	33	6	2	11·2	1	8·96
9	1	3	5·6	...	10·08	34	6	3	5·6	1	10·08
10	2	...	...	...	11·20	35	7	...	...	1	11·20
11	2	...	22·4	...	12·32	36	7	...	22·4	1	12·32
12	2	1	16·8	...	13·44	37	7	1	16·8	1	13·44
13	2	2	11·2	...	14·56	38	7	2	11·2	1	14·56
14	2	3	5·6	...	15·68	39	7	3	5·6	1	15·68
15	3	...	...	...	16·8	40	8	...	...	1	16·8
16	3	...	22·4	...	17·92	41	8	...	22·4	1	17·92
17	3	1	16·8	...	19·04	42	8	1	16·8	1	19·04
18	3	2	11·2	...	20·16	43	8	2	11·2	1	20·16
19	3	3	5·6	...	21·28	44	8	3	5·6	1	21·28
20	4	...	...	...	22·40	45	9	...	...	1	22·40
21	4	...	22·4	...	23·52	46	9	...	22·4	1	23·52
22	4	1	16·8	...	24·64	47	9	1	16·8	1	24·64
23	4	2	11·2	...	25·76	48	9	2	11·2	1	25·76
24	4	3	5·6	...	26·88	49	9	3	5·6	1	26·88
25	5	...	...	1	...	50	10	...	...	2	...

Per cent.	·1	·2	·3	·4	·5	·6	·7	·8	·9
lb. per cwt.	·112	·224	·336	·448	·56	·672	·784	·896	1·008
lb. per ton	2·24	4·48	6·72	8·96	11·2	13·44	15·68	17·92	20·16

TABLE FOR THE CONVERSION OF PERCENTAGE INTO CWTS., QRS., AND LB. PER TON, AND INTO QRS. AND LB. PER CWT.—*continued.*

Per cent.	Per ton.			Per cwt.		Per cent.	Per ton.			Per cwt.	
	cwt.	qrs.	lb.	qrs.	lb.		cwt.	qrs.	lb.	qrs.	lb.
51	10	...	22·4	2	1·12	76	15	...	22·4	3	1·12
52	10	1	16·8	2	2·24	77	15	1	16·8	3	2·24
53	10	2	11·2	2	3·36	78	15	2	11·2	3	3·36
54	10	3	5·6	2	4·48	79	15	3	5·6	3	4·48
55	11	...	...	2	5·60	80	16	...	...	3	5·60
56	11	...	22·4	2	6·72	81	16	...	22·4	3	6·72
57	11	1	16·8	2	7·84	82	16	1	16·8	3	7·84
58	11	2	11·2	2	8·96	83	16	2	11·2	3	8·96
59	11	3	5·6	2	10·08	84	16	3	5·6	3	10·08
60	12	...	...	2	11·20	85	17	...	...	3	11·20
61	12	...	22·4	2	12·32	86	17	...	22·4	3	12·32
62	12	1	16·8	2	13·44	87	17	1	16·8	3	13·44
63	12	2	11·2	2	14·56	88	17	2	11·2	3	14·56
64	12	3	5·6	2	15·68	89	17	3	5·6	3	15·68
65	13	...	...	2	16·8	90	18	...	...	3	16·8
66	13	...	22·4	2	17·92	91	18	...	22·4	3	17·92
67	13	1	16·8	2	19·04	92	18	1	16·8	3	19·04
68	13	2	11·2	2	20·16	93	18	2	11·2	3	20·16
69	13	3	5·6	2	21·28	94	18	3	5·6	3	21·28
70	14	...	...	2	22·40	95	19	...	...	3	22·40
71	14	...	22·4	2	23·52	96	19	...	22·4	3	23·52
72	14	1	16·8	2	24·64	97	19	1	16·8	3	24·64
73	14	2	11·2	2	25·76	98	19	2	11·2	3	25·76
74	14	3	5·6	2	26·88	99	19	3	5·6	3	26·88
75	15	...	...	3	...	100	20	...	...	4	...

Per cent.	·1	·2	·3	·4	·5	·6	·7	·8	·9
lb. per cwt.	·112	·224	·336	·448	·56	·672	·784	·896	1·008
lb. per ton	2·24	4·48	6·72	8·96	11·2	13·44	15·68	17·92	20·16

TABLE FOR THE CONVERSION OF DRACHMS PER LB. INTO PERCENTAGE AND INTO LB. PER TON.

Drachms per lb. (av.)	Per cent.	Lb. per ton (2240 lb.).	Drachms per lb. (av.)	Per cent.	Lb. per ton (2240 lb.).
¼	0·097656 (or 0·1 nearly)	2·187494	1¼	·488	10·94
			1½	·586	13·12
½	·195	4·37	1¾	·683	15·31
¾	·293	6·56	2	·781	17·50
1	·390625*	8·75†	2¼	·879	19·68

* Log. 1·5917600. † Log. 0·9420000.

TABLE FOR THE CONVERSION OF DRACHMS PER LB. INTO PERCENTAGE AND INTO LB. PER TON—*continued.*

Drachms per lb. (av.)	Per cent.	Lb. per ton (2240 lb.).	Drachms per lb. (av.)	Per cent.	Lb. per ton (2240 lb.).
$2\frac{1}{2}$	·976	21·87	5	1·953	43·75
$2\frac{3}{4}$	1·074	24·06	10	3·906	87·50
3	1·172	26·25	15	5·859	131·25
$3\frac{1}{4}$	1·269	28·43	20	7·812	175·00
$3\frac{1}{2}$	1·367	30·62	25	9·765	218·75
$3\frac{3}{4}$	1·465	32·81	30	11·719	262·50
4	1·562	35·00	35	13·672	306·25
$4\frac{1}{4}$	1·660	37·19	40	15·625	350·00
$4\frac{1}{2}$	1·758	39·38	45	17·578	393·75
$4\frac{3}{4}$	1·855	41·56	50	19·531	437·50

TABLES REQUIRED IN WATER ANALYSIS.

I. *Tension of Aqueous Vapour in Millimetres of Mercury from 0° to 35° C.*

° C.	mm.	° C.	mm.	° C.	mm.	° C.	mm.	° C.	mm.
0·0	4·600	2·5	5·491	5·0	6·534	7·5	7·751	10·0	9·165
·1	·633	·6	·530	·1	·580	·6	·804	·1	·227
·2	·667	·7	·569	·2	·625	·7	·857	·2	·288
·3	·700	·8	·608	·3	·671	·8	·910	·3	·350
·4	·733	·9	·647	·4	·717	·9	·964	·4	·412
0·5	·767	3·0	5·687	5·5	·763	8·0	8·017	10·5	·474
·6	·801	·1	·727	·6	·810	·1	·072	·6	·537
·7	·836	·2	·767	·7	·857	·2	·126	·7	·601
·8	·871	·3	·807	·8	·904	·3	·181	·8	·665
·9	·905	·4	·848	·9	·951	·4	·236	·9	·728
1·0	4·940	3·5	·890	6·0	6·998	8·5	·291	11·0	9·792
·1	·975	·6	·930	·1	7·047	·6	·347	·1	·857
·2	5·011	·7	·972	·2	·095	·7	·404	·2	·923
·3	·047	·8	6·014	·3	·144	·8	·461	·3	·989
·4	·082	·9	·056	·4	·193	·9	·517	·4	10·054
1·5	·118	4·0	6·097	6·5	·242	9·0	8·574	11·5	·120
·6	·155	·1	·140	·6	·292	·1	·632	·6	·187
·7	·191	·2	·183	·7	·342	·2	·690	·7	·255
·8	·228	·3	·226	·8	·392	·3	·748	·8	·322
·9	·265	·4	·270	·9	·442	·4	·807	·9	·389
2·0	5·302	4·5	·313	7·0	7·492	9·5	·865	12·0	10·457
·1	·340	·6	·357	·1	·544	·6	·925	·1	·526
·2	·378	·7	·401	·2	·595	·7	·985	·2	·596
·3	·416	·8	·445	·3	·647	·8	9·045	·3	·665
·4	·454	·9	·490	·4	·699	·9	·105	·4	·734

TABLES REQUIRED IN WATER ANALYSIS. TABLE I.—*continued.*

° C.	mm.	° C.	mm.	° C.	mm.	° C.	mm.	° C.	mm.
12·5	10·804	17·1	14·513	21·7	19·305	26·3	25·438	30·9	33·215
·6	·875	·2	·605	·8	·423	·4	·588	31·0	33·405
·7	·947	·3	·697	·9	·541	26·5	·738	·1	·596
·8	11·019	·4	·790	22·0	19·659	·6	·891	·2	·787
·9	·090	17·5	·882	·1	·780	·7	26·045	·3	·980
13·0	11·162	·6	·977	·2	·901	·8	·198	·4	34·174
·1	·235	·7	15·072	·3	20·022	·9	·351	31·5	·368
·2	·309	·8	·167	·4	·143	27·0	26·505	·6	·564
·3	.383	·9	·262	22·5	·265	·1	·663	·7	·761
·4	·456	18·0	15·357	·6	·389	·2	·820	·8	·959
13·5	·530	·1	·454	·7	·514	·3	·978	·9	35·159
·6	·605	·2	·552	·8	·639	·4	27·136	32·0	35·359
·7	·681	·3	·650	·9	·763	27·5	·294	·1	·559
·8	·757	·4	·747	23·0	20·888	·6	·455	·2	·760
·9	·832	18·5	·845	·1	21·016	·7	·617	·3	·962
14·0	11·908	·6	·945	·2	·144	·8	·778	·4	36·165
·1	·986	·7	16·045	·3	·272	·9	·939	32·5	·370
·2	12·064	·8	·145	·4	·400	28·0	28·101	·6	·576
·3	·142	·9	·246	23·5	·528	·1	·267	·7	·783
·4	·220	19·0	16·346	·6	21·659	·2	·433	·8	·991
14·5	·298	·1	·449	·7	·790	·3	·599	·9	37·200
·6	·378	·2	·552	·8	·921	·4	·765	33·0	37·410
·7	·458	·3	·655	·9	22·053	28·5	·931	·1	·621
·8	·538	·4	·758	24·0	22·184	·6	29·101	·2	·832
·9	·619	19·5	·861	·1	·319	·7	·271	·3	38·045
15·0	12·699	·6	·967	·2	·453	·8	·441	·4	·258
·1	·781	·7	17·073	·3	·588	·9	·612	33·5	·473
·2	·864	·8	·179	·4	·723	29·0	29·782	·6	·689
·3	·947	·9	·285	24·5	·858	·1	·956	·7	·906
·4	13·029	20·0	17·391	·6	·996	·2	30·131	·8	39·124
15·5	·112	·1	·500	·7	23·135	·3	·305	·9	·344
·6	·197	·2	·608	·8	·273	·4	·479	34·0	39·565
·7	·281	·3	·717	·9	·411	29·5	·654	·1	·786
·8	·366	·4	·826	25·0	23·550	·6	·833	·2	40·007
·9	·451	20·5	·935	·1	·692	·7	31·011	·3	·230
16·0	13·536	·6	18·047	·2	·834	·8	·190	·4	·455
·1	·623	·7	·159	·3	·976	·9	·369	34·5	·680
·2	·710	·8	·271	·4	24·119	30·0	31·548	·6	·907
·3	·797	·9	·383	25·5	·261	·1	·729	·7	41·135
·4	·885	21·0	18·495	·6	·406	·2	·911	·8	·364
16·5	·972	·1	·610	·7	·552	·3	32·094	·9	·595
·6	14·062	·2	·724	·8	·697	·4	·278	35·0	·827
·7	·151	·3	·839	·9	·842	30·5	·463		
·8	·241	·4	·954	26·0	24·988	·6	·650		
·9	·331	21·5	19·069	·1	25·138	·7	·837		
17·0	14·421	·6	·187	·2	·288	·8	33·026		

Tables required in Water Analysis—*continued.*

II. *Reduction of Cubic Centimetres of Nitrogen to Grams.*

$\text{Log.}\dfrac{0 \cdot 0012562}{(1 + \cdot 00367\, t)\, 760}$ for each tenth of a degree from 0° to 30° C.

t C.	0·0	0·1	0·2	0·3	0·4	0·5	0·6	0·7	0·8	0·9
°										
0	$\bar{6}$·21824	808	793	777	761	745	729	713	697	681
1	665	649	633	617	601	586	570	554	538	522
2	507	491	475	459	443	427	412	396	380	364
3	349	333	318	302	286	270	255	239	223	208
4	192	177	161	145	130	114	098	083	067	051
5	035	020	004	*989	*973	*957	*942	*926	*911	*895
6	$\bar{6}$·20879	864	848	833	817	801	786	770	755	739
7	723	708	692	676	661	645	629	614	598	583
8	567	552	536	521	505	490	427	459	443	428
9	413	397	382	366	351	335	320	304	289	274
10	259	244	228	213	198	182	167	151	136	121
11	106	090	075	060	045	029	014	*999	*984	*969
12	$\bar{6}$·19953	938	923	907	892	877	862	846	831	816
13	800	785	770	755	740	724	709	694	679	664
14	648	633	618	603	588	573	558	543	528	513
15	497	482	467	452	437	422	407	392	377	362
16	346	331	316	301	286	271	256	241	226	211
17	196	181	166	157	136	121	106	091	076	061
18	046	031	016	001	*986	*971	*956	*941	*926	*911
19	$\bar{6}$·18897	882	867	852	837	822	807	792	777	762
20	748	733	718	703	688	673	659	644	629	614
21	600	585	570	555	540	526	511	496	481	466
22	452	437	422	408	393	378	363	349	334	319
23	305	290	275	261	246	231	216	202	187	172
24	158	143	128	114	099	084	070	055	041	026
25	012	*997	*982	*968	*953	*938	*924	*909	*895	*880
26	$\bar{6}$·17866	851	837	822	808	793	779	764	750	735
27	721	706	692	677	663	648	634	619	605	590
28	576	561	547	532	518	503	489	475	460	446
29	432	417	403	388	374	360	345	331	316	302

Tables required in Water Analysis—*continued.*

III. *Loss of Nitrogen by Evaporation of NH_3 with Sulphurous Acid.*

Parts per 100,000.

NH_3	Loss of N	NH_3	Loss of N	NH_3	Loss of N	NH_3	Loss of N	NH_3	Loss of N	NH_3	Loss of N
6·0	1·727	4·8	1·451	3·6	·977	2·4	·503	1·2	·250	·09	·014
5·9	1·707	4·7	1·411	3·5	·937	2·3	·463	1·1	·238	·08	·013
5·8	1·688	4·6	1·372	3·4	·898	2·2	·424	1·0	·226	·07	·012
5·7	1·668	4·5	1·332	3·3	·858	2·1	·384	0·9	·196	·06	·010
5·6	1·648	4·4	1·293	3·2	·819	2·0	·345	·8	·166	·05	·009
5·5	1·628	4·3	1·253	3·1	·779	1·9	·333	·7	·136	·04	·007
5·4	1·609	4·2	1·214	3·0	·740	1·8	·321	·6	·106	·03	·006
5·3	1·589	4·1	1·174	2·9	·700	1·7	·309	·5	·077	·02	·004
5·2	1·569	4·0	1·135	2·8	·661	1·6	·297	·4	·062	·01	·003
5·1	1·549	3·9	1·095	2·7	·621	1·5	·285	·3	·047	·009	·001
5·0	1·530	3·8	1·056	2·6	·582	1·4	·274	·2	·032		
4·9	1·490	3·7	1·016	2·5	·542	1·3	·262	·1	0·17		

IV. *Loss of Nitrogen by Evaporation of NH_3 with Hydric Metaphosphate.*

Parts per 100,000.

Volume evaporated.	NH_3	Loss of N	Volume evaporated.	NH_3	Loss of N	Volume evaporated.	NH_3	Loss of N
100 c.c.	10·0	·483	100 c.c.	8·3	·424	100 c.c.	6·6	·365
,,	9·9	·480	,,	8·2	·421	,,	6·5	·361
,,	9·8	·476	,,	8·1	·417	,,	6·4	·358
,,	9·7	·473	,,	8·0	·414	,,	6·3	·354
,,	9·6	·469	,,	7·9	·410	,,	6·2	·351
,,	9·5	·466	,,	7·8	·407	,,	6·1	·348
,,	9·4	·462	,,	7·7	·403	,,	6·0	·345
,,	9·3	·459	,,	7·6	·400	,,	5·9	·341
,,	9·2	·455	,,	7·5	·396	,,	5·8	·337
,,	9·1	·452	,,	7·4	·393	,,	5·7	·333
,,	9·0	·448	,,	7·3	·389	,,	5·6	·330
,,	8·9	·445	,,	7·2	·386	,,	5·5	·326
,,	8·8	·441	,,	7·1	·382	,,	5·4	·322
,,	8·7	·438	,,	7·0	·379	,,	5·3	·318
,,	8·6	·434	,,	6·9	·375	,,	5·2	·314
,,	8·5	·431	,,	6·8	·372	,,	5·1	·310
,,	8·4	·428	,,	6·7	·368	,,	5·0	·306

TABLES REQUIRED IN WATER ANALYSIS. TABLE IV.—*continued.*

Volume evaporated.	NH_3	Loss of N	Volume evaporated.	NH_3	Loss of N	Volume evaporated.	NH_3	Loss of N
100 c.c.	4·9	·302	100 c.c.	2·9	·211	250 c.c.	·9	·096
,,	4·8	·298	,,	2·8	·205	,,	·8	·080
,,	4·7	·294	,,	2·7	·200	,,	·7	·070
,,	4·6	·291	,,	2·6	·195	,,	·6	·060
,,	4·5	·287	,,	2·5	·190	500 c.c.	·5	·050
,,	4·4	·283	,,	2·4	·184	,,	·4	·040
,,	4·3	·279	,,	2·3	·179	,,	·3	·030
,,	4·2	·275	,,	2·2	·174	1000 c.c.	·2	·020
,,	4·1	·271	,,	2·1	·169	,,	·1	·010
,,	4·0	·267	,,	2·0	·164	,,	·09	·009
,,	3·9	·262	,,	1·9	·158	,,	·08	·008
,,	3·8	·257	,,	1·8	·153	,,	·07	·007
,,	3·7	·252	,,	1·7	·148	,,	·06	·006
,,	3·6	·247	,,	1·6	·143	,,	·05	·005
,,	3·5	·242	,,	1·5	·137	,,	·04	·004
,,	3·4	·236	,,	1·4	·132	,,	·03	·003
,,	3·3	·231	,,	1·3	·127	,,	·02	·002
,,	3·2	·226	,,	1·2	·122	,,	·01	·001
,,	3·1	·221	,,	1·1	·117			
,,	3·0	·216	,,	1·0	·112			

V. *Loss of Nitrogen by Evaporation of NH_3 with Sulphurous Acid.*

Parts per 100,000.

N as NH_3	Loss of N	N as NH_3	Loss of N	N as NH_3	Loss of N	N as NH_3	Loss of N	N as NH_3	Loss of N	N as NH_3	Loss of N
5·0	1·741	3·9	1·425	2·9	·946	1·9	·466	·9	·237	·08	·017
4·9	1·717	3·8	1·378	2·8	·898	1·8	·418	·8	·217	·07	·015
4·8	1·693	3·7	1·330	2·7	·850	1·7	·370	·7	·181	·06	·013
4·7	1·669	3·6	1·282	2·6	·802	1·6	·338	·6	·145	·05	·011
4·6	1·645	3·5	1·234	2·5	·754	1·5	·324	·5	·109	·04	·009
4·5	1·621	3·4	1·186	2·4	·706	1·4	·309	·4	·075	·03	·007
4·4	1·598	3·3	1·138	2·3	·658	1·3	·295	·3	·057	·02	·005
4·3	1·574	3·2	1·090	2·2	·610	1·2	·280	·2	·038	·01	·003
4·2	1·550	3·1	1·042	2·1	·562	1·1	·266	·1	·020	·008	·002
4·1	1·521	3·0	·994	2·0	·514	1·0	·252	·09	·018	·007	·001
4·0	1·473										

Tables required in Water Analysis—*continued.*

VI. *Loss of Nitrogen by Evaporation of NH_3 with Hydric Metaphosphate.*

Parts per 100,000.

Volume evaporated.	N as NH_3	Loss of N	Volume evaporated.	N as NH_3	Loss of N	Volume evaporated.	N as NH_3	Loss of N
100 c.c.	8·2	·482	100 c.c.	5·1	·352	100 c.c.	2·1	·192
,,	8·1	·477	,,	5·0	·347	,,	2·0	·186
,,	8·0	·473	,,	4·9	·343	,,	1·9	·180
,,	7·9	·469	,,	4·8	·338	,,	1·8	·173
,,	7·8	·465	,,	4·7	·334	,,	1·7	·167
,,	7·7	·461	,,	4·6	·329	,,	1·6	·161
,,	7·6	·456	,,	4·5	·324	,,	1·5	·154
,,	7·5	·452	,,	4·4	·319	,,	1·4	·148
,,	7·4	·448	,,	4·3	·315	,,	1·3	·142
,,	7·3	·444	,,	4·2	·310	,,	1·2	·136
,,	7·2	·440	,,	4·1	·305	,,	1·1	·129
,,	7·1	·435	,,	4·0	·301	,,	1·0	·123
,,	7·0	·431	,,	3·9	·296	,,	·9	·117
,,	6·9	·427	,,	3·8	·291	,,	·8	·111
,,	6·8	·423	,,	3·7	·286	250 c.c.	·7	·088
,,	6·7	·419	,,	3·6	·281	,,	·6	·073
,,	6·6	·414	,,	3·5	·277	,,	·5	·061
,,	6·5	·410	,,	3·4	·272	500 c.c.	·4	·049
,,	6·4	·406	,,	3·3	·267	,,	·3	·036
,,	6·3	·402	,,	3·2	·261	1000 c.c.	·2	·024
,,	6·2	·398	,,	3·1	·255	,,	·1	·012
,,	6·1	·394	,,	3·0	·249	,,	·09	·011
,,	6·0	·389	,,	2·9	·242	,,	·08	·010
,,	5·9	·385	,,	2·8	·236	,,	·07	·008
,,	5·8	·381	,,	2·7	·230	,,	·06	·007
,,	5·7	·377	,,	2·6	·223	,,	·05	·006
,,	5·6	·373	,,	2·5	·217	,,	·04	·005
,,	5·5	·368	,,	2·4	·211	,,	·03	·004
,,	5·4	·364	,,	2·3	·205	,,	·02	·002
,,	5·3	·360	,,	2·2	·198	,,	·01	·001
,,	5·2	·356						

VII. *Table of Hardness.*

(50 c.c. of water used.)

Volume of Soap solution.	$CaCO_3$ per 100,000	Degrees of Hardness.*	Volume of Soap solution.	$CaCO_3$ per 100,000	Degrees of Hardness.	Volume of Soap solution.	$CaCO_3$ per 100,000	Degrees of Hardness.
c.c.			c.c.			c.c.		
0·7	0·00	0·00	1·3	0·95	0·67	1·9	1·82	1·27
0·8	0·16	0·11	·4	1·11	0·78	2·0	1·95	1·37
0·9	0·32	0·22	·5	1·27	0·89	·1	2·08	1·46
1·0	0·48	0·34	·6	1·43	1·00	·2	2·21	1·55
·1	0·63	0·44	·7	1·56	1·09	·3	2·34	1·64
·2	0·79	0·55	·8	1·69	1·18	·4	2·47	1·73

* Each degree of hardness indicates one grain of $CaCO_3$ per gallon.

TABLES REQUIRED IN WATER ANALYSIS. TABLE VII.—*continued.*

Volume of Soap solution.	$CaCO_3$ per 100,000	Degrees of Hardness.*	Volume of Soap solution.	$CaCO_3$ per 100,000	Degrees of Hardness.	Volume of Soap solution.	$CaCO_3$ per 100,000	Degrees of Hardness.
c.c.			c.c.			c.c.		
2·5	2·60	1·82	7·1	9·00	6·30	11·7	15·95	11·17
·6	2·73	1·91	·2	9·14	6·40	·8	16·11	11·28
·7	2·86	2·00	·3	9·29	6·50	·9	16·27	11·39
·8	2·99	2·09	·4	9·43	6·60	12·0	16·43	11·50
·9	3·12	2·18	·5	9·57	6·70	·1	16·59	11·61
3·0	3·25	2·28	·6	9·71	6·80	·2	16·75	11·73
·1	3·38	2·37	·7	9·86	6·90	·3	16·90	11·83
·2	3·51	2·46	·8	10·00	7·00	·4	17·06	11·94
·3	3·64	2·55	·9	10·15	7·11	·5	17·22	12·05
·4	3·77	2·64	8·0	10·30	7·21	·6	17·38	12·17
·5	3·90	2·73	·1	10·45	7·32	·7	17·54	12·28
·6	4·03	2·82	·2	10·60	7·42	·8	17·70	12·39
·7	4·16	2·91	·3	10·75	7·53	·9	17·86	12·50
·8	4·29	3·00	·4	10·90	7·63	13·0	18·02	12·61
·9	4·43	3·10	·5	11·05	7·74	·1	18·17	12·72
4·0	4·57	3·20	·6	11·20	7·84	·2	18·33	12·83
·1	4·71	3·30	·7	11·35	7·95	·3	18·49	12·94
·2	4·86	3·40	·8	11·50	8·05	·4	18·65	13·06
·3	5·00	3·50	·9	11·65	8·16	·5	18·81	13·17
·4	5·14	3·60	9·0	11·80	8·26	·6	18·97	13·28
·5	5·29	3·70	·1	11·95	8·37	·7	19·13	13·39
·6	5·43	3·80	·2	12·11	8·48	·8	19·29	13·50
·7	5·57	3·90	·3	12·26	8·58	·9	19·44	13·61
·8	5·71	4·00	·4	12·41	8·69	14·0	19·60	13·72
·9	5·86	4·10	·5	12·56	8·79	·1	19·76	13·83
5·0	6·00	4·20	·6	12·71	8·90	·2	19·92	13·94
·1	6·14	4·30	·7	12·86	9·00	·3	20·08	14·06
·2	6·29	4·40	·8	13·01	9·11	·4	20·24	14·17
·3	6·43	4·50	·9	13·16	9·21	·5	20·40	14·28
·4	6·57	4·60	10·0	13·31	9·32	·6	20·56	14·39
·5	6·71	4·70	·1	13·46	9·42	·7	20·71	14·50
·6	6·86	4·80	·2	13·61	9·53	·8	20·87	14·61
·7	7·00	4·90	·3	13·76	9·63	·9	21·03	14·72
·8	7·14	5·00	·4	13·91	9·74	15·0	21·19	14·83
·9	7·29	5·10	·5	14·06	9·84	·1	21·35	14·95
6·0	7·43	5·20	·6	14·21	9·95	·2	21·51	15·06
·1	7·57	5·30	·7	14·37	10·06	·3	21·68	15·18
·2	7·71	5·40	·8	14·52	10·16	·4	21·85	15·30
·3	7·86	5·50	·9	14·68	10·28	·5	22·02	15·41
·4	8·00	5·60	11·0	14·84	10·39	·6	22·18	15·53
·5	8·14	5·70	·1	15·00	10·50	·7	22·35	15·65
·6	8·29	5·80	·2	15·16	10·61	·8	22·52	15·76
·7	8·43	5·90	·3	15·32	10·72	·9	22·69	15·88
·8	8·57	6·00	·4	15·48	10·84	16·0	22·86	16·00
·9	8·71	6·10	·5	15·63	10·94			
7·0	8·86	6·20	·6	15·79	11·05			

* Each degree of hardness indicates one grain of $CaCO_3$ per gallon.

TABLES REQUIRED IN WATER ANALYSIS—*continued.*

VIII. *Clark's Table of Hardness of Water.*

Degrees of Hardness.	Measures of Soap solution.	Differences for the next 1° of Hardness.	Degrees of Hardness.	Measures of Soap solution.	Differences for the next 1° of Hardness.
0 (distilled water)	1·4	1·8	8	17·5	1·9
			9	19·4	1·9
1	3·2	2·2	10	21·3	1·8
2	5·4	2·2	11	23·1	1·8
3	7·6	2·0	12	24·9	1·8
4	9·6	2·0	13	26·7	1·8
5	11·6	2·0	14	28·5	1·8
6	13·6	2·0	15	30·3	1·7
7	15·6	1·9	16	32·0	...

Each measure equals 10 grains, the quantity of water operated upon equals 1000 grains, and each "degree of hardness" indicates 1 grain of calcic carbonate per gallon.

THE ESTIMATION OF NITRATES IN WATER BY SPRENGEL'S METHOD.

Solutions required.

(1) *Phenol-Sulphonic Acid.*—Mix together 2 parts by measure of phenol and 5 parts of pure concentrated sulphuric acid, and heat in a porcelain basin on the water-bath for about 8 hours. When cool, add 1½ volumes of water and ½ volume strong hydrochloric acid to each volume of the phenol-sulphonic acid.

Convenient quantities are 80 c.c. phenol, 200 c.c. H_2SO_4; 420 c.c. water and 140 c.c. HCl, producing 840 c.c. of a light brown solution, which is ready for immediate use.

(2) *Standard Potassium Nitrate.*—0·0722 gram KNO_3 crystals are dissolved in a litre of water.*

10 c.c. = 0·0001 gram N, or 1 part of N in 100,000 of water when 10 c.c. are evaporated.

The estimation is made as follows:—10 c.c. of the water under examination and 10 c.c. standard KNO_3 are pipetted into two small beakers and evaporated nearly to dryness on a hot iron plate, the operation being completed on the top of a water-oven. As this operation usually takes about an hour and a half, it is better, when time is an object, to evaporate to dryness in a platinum dish over steam. The residue in each case is treated with 1 c.c. of the phenol-sulphonic acid, which is brought into contact with the whole of the residue, and the beakers are placed on the top of the water-

* The best plan is to dissolve 0·7220 gram KNO_3 in a litre of distilled water; then, keeping this as a stock strong solution, dilute 100 c.c. of it to 1 litre for use as required.

oven. When nitrates are present in quantity, the liquid speedily assumes a red colour, which, in the case of a good water, will not appear for about 10 minutes. After 15 minutes' standing, the beakers are removed, the contents of each washed out successively into a 100 c.c. graduated measure, a slight excess (about 20 c.c. of 0·96) of ammonia added, the 100 c.c. made up by the addition of water and the yellow liquid transferred to a Nessler glass (6 in. × $1\frac{1}{2}$ in.). The more strongly coloured liquid is then partly transferred to the measure again and the tints compared a second time. In this way the tints are adjusted, the volume of the stronger liquid being, for final comparison, made up to 100 c.c.

In the case of very good waters, 20, 50, or more c.c. should be evaporated in a short, wide beaker to a small bulk, rinsed into a small beaker, and evaporated to dryness and treated as above—only 5 c.c. of the standard potassium nitrate (=0·5 N in 100,000 of water on the basis of 10 c.c. water taken) being used for comparison. In the case of very bad waters, 10 c.c. should be pipetted into a 100 c.c. measuring flask and made up to the mark with distilled water: then 10 c.c. of the well mixed liquid (=1 c.c. original water) are withdrawn and treated as above.

According to A. H. Gill, this process does not estimate the nitrogen present as nitrite, as the action of nitrous acid results in the formation of nitrosophenol $C_6H_4(NO)(OH)$, which is colourless in dilute solutions (see abstract in *Jour. Soc. Chem. Ind.*, 1895, p. 71).

TABLES REQUIRED IN WATER ANALYSIS—*continued.*

IX. *Estimation of Nitrogen as Nitrates by Sprengel's Method* (*for waters containing more than one part of N in* 100,000).

No. of c.c. of yellow solution equal to the standard 100 c.c.	Nitrogen as Nitrates.		No. of c.c. of yellow solution equal to the standard 100 c.c.	Nitrogen as Nitrates.	
	Parts per 100,000.	Grains per gallon.		Parts per 100,000.	Grains per gallon.
100	1·00	0·70	50	2·00	1·40
95	1·05	0·74	48	2·08	1·46
90	1·11	0·78	46	2·17	1·52
85	1·18	0·83	45	2·22	1·55
80	1·25	0·88	44	2·23	1·56
78	1·28	0·90	42	2·38	1·67
76	1·32	0·92	40	2·50	1·75
75	1·33	0·93	38	2·63	1·84
74	1·35	0·95	36	2·78	1·95
72	1·39	0·97	35	2·86	2·00
70	1·43	1·00	34	2·94	2·06
68	1·47	1·03	32	3·13	2·19
66	1·51	1·06	30	3·33	2·33
65	1·54	1·08	28	3·57	2·50
64	1·55	1·09	26	3·85	2·70
62	1·61	1·13	25	4·00	2·80
60	1·67	1·17	24	4·17	2·92
58	1·72	1·20	22	4·55	3·19
56	1·78	1·25	20	5·00	3·50
55	1·82	1·27	18	5·55	3·89
54	1·85	1·30	16	6·25	4·38
52	1·92	1·34	15	6·67	4·67

X. *Table for the Conversion of Parts per* 100,000 *into Grains per Gallon.*

Parts per 100,000.	Grains per gallon.	Parts per 100,000.	Grains per gallon.	Parts per 100,000.	Grains per gallon.	Parts per 100,000.	Grains per gallon.
1	0·7	9	6·3	17	11·9	25	17·5
2	1·4	10	7·0	18	12·6	26	18·2
3	2·1	11	7·7	19	13·3	27	18·9
4	2·8	12	8·4	20	14·0	28	19·6
5	3·5	13	9·1	21	14·7	29	20·3
6	4·2	14	9·8	22	15·4	30	21·0
7	4·9	15	10·5	23	16·1	31	21·7
8	5·6	16	11·2	24	16·8	32	22·4

TABLES REQUIRED IN WATER ANALYSIS. TABLE X.—*continued.*

Parts per 100,000.	Grains per gallon.	Parts per 100,000.	Grains per gallon.	Parts per 100,000.	Grains per gallon.	Parts per 100,000.	Grains per gallon.
33	23·1	78	54·6	123	86·1	168	117·6
34	23·8	79	55·3	124	86·8	169	118·3
35	24·5	80	56·0	125	87·5	170	119·0
36	25·2	81	56·7	126	88·2	171	119·7
37	25·9	82	57·4	127	88·9	172	120·4
38	26·6	83	58·1	128	89·6	173	121·1
39	27·3	84	58·8	129	90·3	174	121·8
40	28·0	85	59·5	130	91·0	175	122·5
41	28·7	86	60·2	131	91·7	176	123·2
42	29·4	87	60·9	132	92·4	177	123·9
43	30·1	88	61·6	133	93·1	178	124·6
44	30·8	89	62·3	134	93·8	179	125·3
45	31·5	90	63·0	135	94·5	180	126·0
46	32·2	91	63·7	136	95·2	181	126·7
47	32·9	92	64·4	137	95·9	182	127·4
48	33·6	93	65·1	138	96·6	183	128·1
49	34·3	94	65·8	139	97·3	184	128·8
50	35·0	95	66·5	140	98·0	185	129·5
51	35·7	96	67·2	141	98·7	186	130·2
52	36·4	97	67·9	142	99·4	187	130·9
53	37·1	98	68·6	143	100·1	188	131·6
54	37·8	99	69·3	144	100·8	189	132·3
55	38·5	100	70·0	145	101·5	190	133·0
56	39·2	101	70·7	146	102·2	191	133·7
57	39·9	102	71·4	147	102·9	192	134·4
58	40·6	103	72·1	148	103·6	193	135·1
59	41·3	104	72·8	149	104·3	194	135·8
60	42·0	105	73·5	150	105·0	195	136·5
61	42·7	106	74·2	151	105·7	196	137·2
62	43·4	107	74·9	152	106·4	197	137·9
63	44·1	108	75·6	153	107·1	198	138·6
64	44·8	109	76·3	154	107·8	199	139·3
65	45·5	110	77·0	155	108·5	200	140·0
66	46·2	111	77·7	156	109·2	201	140·7
67	46·9	112	78·4	157	109·9	202	141·4
68	47·6	113	79·1	158	110·6	203	142·1
69	48·3	114	79·8	159	111·3	204	142·8
70	49·0	115	80·5	160	112·0	205	143·5
71	49·7	116	81·2	161	112·7	206	144·2
72	50·4	117	81·9	162	113·4	207	144·9
73	51·1	118	82·6	163	114·1	208	145·6
74	51·8	119	83·3	164	114·8	209	146·3
75	52·5	120	84·0	165	115·5	210	147·0
76	53·2	121	84·7	166	116·2	211	147·7
77	53·9	122	85·4	167	116·9	212	148·4

TABLES REQUIRED IN WATER ANALYSIS. TABLE X.—*continued.*

Parts per 100,000.	Grains per gallon.	Parts per 100,000.	Grains per gallon.	Parts per 100,000.	Grains per gallon.	Parts per 100,000.	Grains per gallon.
213	149·1	223	156·1	233	163·1	243	170·1
214	149·8	224	156·8	234	163·8	244	170·8
215	150·5	225	157·5	235	164·5	245	171·5
216	151·2	226	158·2	236	165·2	246	172·2
217	151·9	227	158·9	237	165·9	247	172·9
218	152·6	228	159·6	238	166·6	248	173·6
219	153·3	229	160·3	239	167·3	249	174·3
220	154·0	230	161·0	240	168·0	250	175·0
221	154·7	231	161·7	241	168·7		
222	155·4	232	162·4	242	169·4		

CALCULATION OF THE RESULTS OF WATER ANALYSIS.

Substance estimated.	Quantity of Water taken.	To get Grains per gallon.	Logarithms.
N as HNO_3(Crum)	250 c.c.	*c.c. of NO × 0·175 = N	$\bar{1}$·243 0380
NH_3 (copper zinc)	100 c.c.	grams of NH_3 × 576·45 = N	2·760 7616
„ (aluminium)	50 c.c.	„ × 1152·9 = N	3·061 7916
Free or alb. NH_3	500 c.c.	c.c. standard NH_4Cl × ·0014 = NH_3	$\bar{3}$·146 1280
O absorbed	250 c.c. + 10 c.c. $K_2Mn_2O_8$	$0·28 \left(\frac{S-W}{S}\right)$†	
,,	250 c.c. + 15 c.c. $K_2Mn_2O_8$	$0·28 \left(\frac{1·5S-W}{S}\right)$†	
Total solids	250 c.c.	grams × 280	2·447 1580

* Or thus. Let v = vol. of NO obtained from 250 c.c. of the water.
b = height of Bar.
w = tension of aqueous vapour at the observed temperature (see Table I.).

Then N in grains per gallon $= v \times \frac{·0012562}{760(1+·00367\,t)} \times (b-w) \times 140.$

For logs. of $\frac{·0012562}{760(1+·00367\,t)}$ for different values of t see Table II.

Log. 140 = 2·146 1280.

† S = c.c of $Na_2S_2O_3$ corresponding to 10 c.c. $K_2Mn_2O_8$.
W = „ „ required by the water under examination.

VOLUME AND DENSITY OF WATER AT DIFFERENT TEMPERATURES.

Temp.	Sp. gr. of Water (at 0° = 1).	Vol. of Water (at 0° = 1).	Sp. gr. of Water (at 4° = 1).	Vol. of Water (at 4° = 1).
0°	1·000000	1·000000	·999871	1·000129
1	1·000057	0·999943	·999928	1·000072
2	1·000098	·999902	·999969	1·000031
3	1·000120	·999880	·999991	1·000009
4	1·000129	·999871	1·000000	1·000000
5	1·000119	·999881	0·999990	1·000010
6	1·000099	·999901	·999970	1·000030
7	1·000062	·999938	·999933	1·000067
8	1·000015	·999985	·999886	1·000114
9	0·999953	1·000047	·999824	1·000176
10	·999876	1·000124	·999747	1·000253
11	·999784	1·000216	·999655	1·000345
12	·999678	1·000322	·999549	1·000451
13	·999559	1·000441	·999430	1·000570
14	·999429	1·000572	·999299	1·000701
15	·999289	1·000712	·999160	1·000841
16	·999131	1·000870	·999002	1·000999
17	·998970	1·001031	·998841	1·001160
18	·998782	1·001219	·998654	1·001348
19	·998588	1·001413	·998460	1·001542
20	·998388	1·001615	·998259	1·001744
21	·998176	1·001828	·998047	1·001957
22	·997953	1·002049	·997826	1·002177
23	·997730	1·002276	·997601	1·002405
24	·997495	1·002511	·997367	1·002641
25	·997249	1·002759	·997120	1·002888
26	·996994	1·003014	·996866	1·003144
27	·996732	1·003278	·996603	1·003408
28	·996460	1·003553	·996331	1·003682
29	·996179	1·003835	·996051	1·003965
30	·995894	1·004123	·995765	1·004253
35	·99431	1·00572	·99418	1·00586
40	·99248	1·00757	·99235	1·00770
50	·98833	1·01181	·98820	1·01195
60	·98351	1·01677	·98338	1·01691
70	·97807	1·02243	·97794	1·02256
80	·97206	1·02874	·97194	1·02887
90	·96568	1·03554	·96556	1·03567
100	·95878	1·04300	·95865	1·04312

The Barometer.

I. *Inches into Millimetres.*

Inches.	Milli-metres.	Inches.	Milli-metres.	Inches.	Milli-metres.	Inches.	Milli-metres.
27·5	698·49	28·4	721·35	29·3	744·21	30·2	767·07
·6	701·03	·5	723·89	·4	746·75	·3	769·61
·7	703·57	·6	726·43	·5	749·29	·4	772·15
·8	706·11	·7	728·97	·6	751·83	·5	774·69
·9	708·65	·8	731·51	·7	754·37	·6	777·23
28·0	711·19	·9	734·05	·8	756·91	·7	779·77
·1	713·73	29·0	736·59	·9	759·45	·8	782·31
·2	716·27	·1	739·13	30·0	761·99	·9	784·85
·3	718·81	·2	741·67	·1	764·53		

Inches,	·01	·02	·03	·04	·05	·06	·07	·08	·09
Millimetres,	·25	·51	·76	1·02	1·27	1·52	1·78	2·03	2·29

II. *Millimetres into Inches.*

Mm.	Inches.	Mm.	Inches.	Mm.	Inches.	Mm.	Inches.	Mm.	Inches.
700	27·56	718	28·27	735	28·94	752	29·61	769	30·28
701	·60	719	·31	736	·98	753	·65	770	·32
702	·64	720	·35	737	29·02	754	·69	771	·36
703	·68	721	·39	738	·06	755	·73	772	·39
704	·72	722	·43	739	·10	756	·76	773	·43
705	·76	723	·47	740	·13	757	·80	774	·47
706	·80	724	·50	741	·17	758	·84	775	·51
707	·84	725	·54	742	·21	759	·88	776	·55
708	·88	726	·58	743	·25	760	·92	777	·59
709	·91	727	·62	744	·29	761	·96	778	·63
710	·95	728	·66	745	·33	762	30·00	779	·67
711	·99	729	·70	746	·37	763	·04	780	·71
712	28·03	730	·74	747	·41	764	·08	781	·75
713	·07	731	·78	748	·45	765	·12	782	·79
714	·11	732	·82	749	·49	766	·16	783	·83
715	·15	733	·86	750	·53	767	·20	784	·87
716	·19	734	·90	751	·57	768	·24	785	·91
717	·23								

Table for Correction of Volumes of Gases for Temperature, giving the Divisor for the Formula.

$$V^1 = \frac{V \times B}{760 \times (1 + \delta t)} \quad \delta = \cdot 003665$$

t	760× (1+δ*t*).	Log. [760× (1+δ*t*)].	*t*	760× (1+δ*t*).	Log. [760× (1+δ*t*)].
° C.			° C.		
0·0	760·0000	2·8808136	4·0	771·1416	2·8871341
·1	760·2785	9727	·1	771·4201	2909
·2	760·5571	2·8811318	·2	771·6987	4477
·3	760·8356	2908	·3	771·9772	6045
·4	761·1142	4498	·4	772·2558	7612
0·5	761·3927	6087	4·5	772·5343	9178
·6	761·6712	7675	·6	772·8128	2·8880743
·7	761·9498	9263	·7	773·0914	2308
·8	762·2283	2·8820850	·8	773·3699	3872
·9	762·5069	2437	·9	773·6485	5436
1·0	762·7854	2·8824024	5·0	773·9270	2·8887000
·1	763·0639	5610	·1	774·2055	8563
·2	763·3425	7195	·2	774·4841	2·8890125
·3	763·6210	8779	·3	774·7626	1687
·4	763·8996	2·8830363	·4	775·0412	3248
1·5	764·1781	1946	5·5	775·3197	4808
·6	764·4566	3528	·6	775·5982	6368
·7	764·7352	5111	·7	775·8768	7927
·8	765·0137	6692	·8	776·1553	9486
·9	765·2923	8273	·9	776·4339	2·8901044
2·0	765·5708	2·8839854	6·0	776·7124	2·8902602
·1	765·8493	2·8841434	·1	776·9909	4159
·2	766·1279	3013	·2	777·2695	5716
·3	766·4064	4591	·3	777·5480	7272
·4	766·6850	6169	·4	777·8266	8828
2·5	766·9635	7747	6·5	778·1051	2·8910383
·6	767·2420	2·8849324	·6	778·3836	1938
·7	767·5206	2·8850901	·7	778·6622	3492
·8	767·7991	2477	·8	778·9407	5045
·9	768·0777	4052	·9	779·2193	6597
3·0	768·3562	2·8855626	7·0	779·4978	2·8918149
·1	768·6347	7199	·1	779·7763	9701
·2	768·9133	8772	·2	780·0549	2·8921252
·3	769·1918	2·8860345	·3	780·3334	2802
·4	769·4704	1918	·4	780·6120	4352
3·5	769·7489	3490	7·5	780·8905	5901
·6	770·0274	5062	·6	781·1690	7450
·7	770·3060	6633	·7	781·4476	8998
·8	770·5845	8203	·8	781·7261	2·8930546
·9	770·8631	9772	·9	782·0047	2093

TABLE FOR CORRECTION OF VOLUMES OF GASES—*continued.*

t	760× (1+δt).	Log. [760× (1+δt)].	t	760× (1+δt).	Log. [760× (1+δt)].
° C.			° C.		
8·0	782·2832	2·8933640	12·5	794·8175	2·9002674
·1	782·5617	5186	·6	795·0960	4196
·2	782·8403	6732	·7	795·3746	5717
·3	783·1188	8277	·8	795·6531	7238
·4	783·3974	9821	·9	795·9317	8758
8·5	783·6959	2·8941365	13·0	796·2102	2·9010277
·6	783·9544	2908	·1	796·4887	1796
·7	784·2330	4451	·2	796·7673	3315
·8	784·5115	5993	·3	797·0458	4833
·9	784·7901	7535	·4	797·3244	6350
9·0	785·0686	2·8949076	13·5	797·6029	7867
·1	785·3471	2·8950617	·6	797·8814	9384
·2	785·6257	2157	·7	798·1600	2·9020900
·3	785·9042	3697	·8	798·4385	2415
·4	786·1828	5236	·9	798·7171	3930
9·5	786·4613	6774	14·0	798·9956	2·9025444
·6	786·7398	8311	·1	799·2741	6957
·7	787·0184	9848	·2	799·5527	8470
·8	787·2969	2·8961385	·3	799·8312	9983
·9	787·5755	2921	·4	800·1098	2·9031495
10·0	787·8540	2·8964457	14·5	800·3883	2·9033007
·1	788·1325	5993	·6	800·6668	4518
·2	788·4111	7528	·7	800·9454	6029
·3	788·6896	9062	·8	801·2239	7539
·4	788·9682	2·8970595	·9	801·5025	9049
10·5	789·2467	2128	15·0	801·7810	2·9040558
·6	789·5252	3660	·1	802·0595	2066
·7	789·8038	5192	·2	802·3381	3574
·8	790·0823	6723	·3	802·6166	5081
·9	790·3609	8254	·4	802·8952	6588
11·0	790·6394	2·8979784	15·5	803·1737	8095
·1	790·9179	2·8981314	·6	803·4522	9601
·2	791·1965	2843	·7	803·7308	2·9051106
·3	791·4750	4372	·8	804·0093	2611
·4	791·7536	2·8985900	·9	804·2879	4115
11·5	792·0321	7428	16·0	804·5664	2·9055619
·6	792·3106	8955	·1	804·8449	7122
·7	792·5892	2·8990482	·2	805·1235	8625
·8	792·8677	2008	·3	805·4020	2·9060127
·9	793·1463	3533	·4	805·6806	1628
12·0	793·4248	2·8995058	16·5	805·9591	2·9063129
·1	793·7033	6582	·6	806·2376	4630
·2	793·9819	8106	·7	806·5162	6130
·3	794·2604	9629	·8	806·7947	7630
·4	794·5390	2·9001152	·9	807·0733	9129

TABLE FOR CORRECTION OF VOLUMES OF GASES—*continued.*

t	$760\times(1+\delta t)$.	Log. $[760\times(1+\delta t)]$.	t	$760\times(1+\delta t)$.	Log. $[760\times(1+\delta t)]$.
° C.			° C.		
17·0	807·3518	2·9070628	21·5	819·8861	2·9137535
·1	807·6303	2126	·6	820·1646	9010
·2	807·9089	3624	·7	820·4432	2·9140485
·3	808·1874	5121	·8	820·7217	1960
·4	808·4660	6618	·9	821·0003	3434
17·5	808·7445	8114	22·0	821·2788	2·9144907
·6	809·0230	2·9079609	·1	821·5573	6380
·7	809·3016	2·9081104	·2	821·8859	7852
·8	809·5801	2598	·3	822·1144	9323
·9	809·8587	4092	·4	822·3930	2·9150794
18·0	810·1372	2·9085586	22·5	822·6715	2265
·1	810·4175	7079	·6	822·9500	3735
·2	810·6943	8571	·7	823·2286	5205
·3	810·9728	2·9090063	·8	823·5071	6674
·4	811·2514	1554	·9	823·7857	8143
18·5	811·5299	3045	23·0	824·0642	2·9159611
·6	811·8084	4535	·1	824·3427	2·9161079
·7	812·0870	6025	·2	824·6213	2546
·8	812·3655	7515	·3	824·8998	4013
·9	812·6441	9004	·4	825·1784	5479
19·0	812·9226	2·9100492	23·5	825·4569	6945
·1	813·2011	1980	·6	825·7354	8410
·2	813·4797	3467	·7	826·0140	9875
·3	813·7582	4954	·8	826·2925	2·9171339
·4	814·0368	6440	·9	826·5711	2802
19·5	814·3153	7926	24·0	826·8496	2·9174265
·6	814·5938	9411	·1	827·1281	5728
·7	814·8724	2·9110896	·2	827·4067	7190
·8	815·1500	2380	·3	827·6852	8652
·9	815·4925	3864	·4	827·9638	2·9180114
20·0	815·7080	2·9115347	24·5	828·2423	1575
·1	815·9865	6830	·6	828·5208	3035
·2	816·2651	8312	·7	828·7994	4495
·3	816·5436	9794	·8	829·0779	5954
·4	816·8222	2·9121275	·9	829·3565	7412
20·5	817·1007	2756	25·0	829·6350	2·9188870
·6	817·3792	4236	·1	829·9135	2·9190328
·7	817·6578	2·9125716	·2	830·1921	1785
·8	817·9363	7195	·3	830·4706	3242
·9	818·2149	8674	·4	830·7492	4699
21·0	818·4934	2·9130152	25·5	831·0277	2·9196155
·1	818·7719	1630	·6	831·3062	7610
·2	819·0505	3107	·7	831·5848	9065
·3	819·3290	4583	·8	831·8633	2·9200520
·4	819·6076	6059	·9	831·1419	1974

Table for Correction of Volumes of Gases—*continued.*

t	760× (1+δt).	Log. [760× (1+δt)].	t	760× (1+δt).	Log. [760× (1+δt)].
° C.			° C.		
26·0	832·4204	2·9203427	28·1	838·2697	2·9233838
·1	832·6989	4880	·2	838·5483	5281
·2	832·9775	6333	·3	838·8268	6723
·3	833·2560	7785	·4	839·1054	8165
·4	833·5346	9237	28·5	839·3839	2·9239606
26·5	833·8131	2·9210688	·6	839·6624	2·9241047
·6	834·0916	2139	·7	839·9410	2488
·7	834·3702	3589	·8	840·2195	3928
·8	834·6487	5038	·9	840·4981	5368
·9	834·9273	6487	29·0	840·7766	2·9246807
27·0	835·2058	2·9217936	·1	841·0551	8246
·1	835·4843	9384	·2	841·3337	9684
·2	835·7629	2·9220832	·3	841·6122	2·9251122
·3	836·0414	2279	·4	841·8908	2559
·4	836·3200	3725	29·5	842·1693	3995
27·5	836·5985	5171	·6	842·4478	5431
·6	836·8770	6617	·7	842·7264	6866
·7	837·1556	8062	·8	843·0049	8301
·8	837·4341	9507	·9	843·2835	9736
·9	837·7127	2·9230951	30·0	843·5620	2·9261171
28·0	837·9912	2·9232395			

Table showing the Tension of Mercury Vapour.

° C.	Millim.	° C.	Millim.	° C.	Millim.	° C.	Millim.
100	·746	210	26·35	320	368·73	430	2533
110	1·073	220	34·70	330	450·91	440	2934
120	1·534	230	45·35	340	548·35	450	3384·35
130	2·175	240	58·82	350	663·18	460	3888
140	3·059	250	75·75	360	797·74	470	4450
150	4·266	260	96·73	370	954·65	480	5062
160	5·900	270	123·01	380	1195·65	490	5761
170	8·091	280	155·17	390	1346·71	500	6520·25
180	11·000	290	194·46	400	1587·96	510	7354
190	14·84	300	242·15	410	1864	520	8265
200	19·90	310	299·69	420	2178		

Tables required in the Analysis of Beer.

Spirit Indication, with corresponding Degrees of Gravity lost in Malt Worts, by the "Distillation Process."

Degrees of Spirit Indication.	·0	·1	·2	·3	·4	·5	·6	·7	·8	·9
0	0·0	0·3	0·6	0·9	1·2	1·5	1·8	2·1	2·4	2·7
1	3·0	3·3	3·7	4·1	4·4	4·8	5·1	5·5	5·9	6·2
2	6·6	7·0	7·4	7·8	8·2	8·6	9·0	9·4	9·8	10·2
3	10·7	11·1	11·5	12·0	12·4	12·9	13·3	13·8	14·2	14·7
4	15·1	15·5	16·0	16·4	16·8	17·3	17·7	18·2	18·6	19·1
5	19·5	19·9	20·4	20·9	21·3	21·8	22·2	22·7	23·1	23·6
6	24·1	24·6	25·0	25·5	26·0	26·4	26·9	27·4	27·8	28·3
7	28·8	29·2	29·7	30·2	30·7	31·2	31·7	32·2	32·7	33·2
8	33·7	34·3	34·8	35·4	35·9	36·5	37·0	37·5	38·0	38·6
9	39·1	39·7	40·2	40·7	41·2	41·7	42·2	42·7	43·2	43·7
10	44·2	44·7	45·1	45·6	46·0	46·5	47·0	47·5	48·0	48·5
11	49·0	49·6	50·1	50·6	51·2	51·7	52·2	52·7	53·3	53·8
12	54·3	54·9	55·4	55·9	56·4	56·9	57·4	57·9	58·4	59·9
13	59·4	60·0	60·5	61·1	61·6	62·2	62·7	63·3	63·8	64·3
14	64·8	65·4	65·9	66·5	67·1	67·6	68·2	68·7	69·3	69·9
15	70·5	71·1	71·7	72·3	72·9	73·5	74·1	74·7	75·3	75·9

Spirit Indication, with corresponding Degrees of Gravity lost in Malt Worts, by the "Evaporation Process."

Degrees of Spirit Indication.	0	·1	·2	·3	·4	·5	·6	·7	·8	·9
0	...	·3	·7	1·0	1·4	1·7	2·1	2·4	2·8	3·1
1	3·5	3·8	4·2	4·6	5·0	5·4	5·8	6·2	6·6	7·0
2	7·4	7·8	8·2	8·7	9·1	9·5	9·9	10·3	10·7	11·1
3	11·5	11·9	12·4	12·8	13·2	13·6	14·0	14·4	14·8	15·3
4	15·8	16·2	16·6	17·0	17·4	17·9	18·4	18·8	19·3	19·8
5	20·3	20·7	21·2	21·6	22·1	22·5	23·0	23·4	23·9	24·3
6	24·8	25·2	25·6	26·1	26·6	27·0	27·5	28·0	28·5	29·0
7	29·5	30·0	30·4	30·9	31·3	31·8	32·3	32·8	33·3	33·8
8	34·3	34·9	35·5	36·0	36·6	37·1	37·7	38·3	38·8	39·4
9	40·0	40·5	41·0	41·5	42·0	42·5	43·0	43·5	44·0	44·4
10	44·9	45·4	46·0	46·5	47·1	47·6	48·2	48·7	49·3	49·8
11	50·3	50·9	51·4	51·9	52·5	53·0	53·5	54·0	54·5	55·0
12	55·6	56·2	56·7	57·3	57·8	58·3	58·9	59·4	59·9	60·5
13	61·0	61·6	62·1	62·7	63·2	63·8	64·3	64·9	65·4	66·0
14	66·5	67·0	67·6	68·1	68·7	69·2	69·8	70·4	70·9	71·4
15	72·0									

Table for ascertaining the Value of the Acetic Acid.

Corresponding Degrees of "Spirit Indication."

Excess per cent. of Acetic Acid in the Beer.	·00	·01	·02	·03	·04	·05	·06	·07	·08	·09
·0	...	·02	·04	·06	·07	·08	·09	·11	·12	·13
·1	·14	·15	·17	·18	·19	·21	·22	·23	·24	·26
·2	·27	·28	·29	·31	·32	·33	·34	·35	·37	·38
·3	·39	·40	·42	·43	·44	·46	·47	·48	·49	·51
·4	·52	·53	·55	·56	·57	·59	·60	·61	·62	·64
·5	·65	·66	·67	·69	·70	·71	·72	·73	·75	·76
·6	·77	·78	·80	·81	·82	·84	·85	·86	·87	·89
·7	·90	·91	·93	·94	·95	·97	·98	·99	1·10	1·02
·8	1·03	1·04	1·05	1·07	1·08	1·09	1·10	1·11	1·13	1·14
·9	1·15	1·16	1·18	1·19	1·21	1·22	1·23	1·25	1·26	1·28
1·0	1·29	1·31	1·33	1·35	1·36	1·37	1·38	1·40	1·41	1·42

Table for Salt in Beer.

Salt in Grains per Gallon, corresponding to c.c.'s of Decinormal $AgNO_3$.
25 c.c. of Beer to be employed.

c.c. $\frac{N}{10}AgNO_3$	Grains NaCl per gallon.	c.c. $\frac{N}{10}AgNO_3$	Grains NaCl per gallon.	c.c. $\frac{N}{10}AgNO_3$	Grains NaCl per gallon.
0·1	1·64	2·2	36·04	4·2	68·80
0·2	3·28	2·3	37·67	4·3	70·43
0·3	4·91	2·4	39·31	4·4	72·07
0·4	6·55	2·5	40·95	4·5	73·71
0·5	8·19	2·6	42·59	4·6	75·35
0·6	9·83	2·7	44·23	4·7	76·99
0·7	11·47	2·8	45·86	4·8	78·62
0·8	13·10	2·9	47·50	4·9	80·26
0·9	14·74	3·0	49·14	5·0	81·90
1·0	16·38	3·1	50·78	5·1	83·54
1·1	18·02	3·2	52·42	5·2	85·18
1·2	19·66	3·3	54·05	5·3	86·81
1·3	21·29	3·4	55·69	5·4	88·45
1·4	22·93	3·5	57·33	5·5	90·09
1·5	24·57	3·6	58·97	5·6	91·73
1·6	26·21	3·7	60·61	5·7	93·37
1·7	27·85	3·8	62·24	5·8	95·00
1·8	29·48	3·9	63·88	5·9	96·64
1·9	31·12	4·0	65·52	6·0	98·28
2·0	32·76	4·1	67·16	6·1	99·92
2·1	34·40				

SPECIFIC ROTATORY POWERS OF THE CARBOHYDRATES.

Definition—The specific rotatory power of an optically active substance in solution may be defined as the angle through which a plane polarized ray of light of definite refrangibility is rotated by a column one decimetre in length of a solution containing one gram of the substance in 1 c.c.

If the rotation is observed through a tube l decimetres in length and the solution contains c grams of substances in 100 c.c., then, if α be the angle of rotation, the "specific rotatory power" is given by the formula,

$$[\alpha] = \frac{\alpha . 100}{l . c.}$$

Observations are usually made either with a polarimeter, such as that of Laurent, for which a sodium flame is used as the means of illumination ; or with a Ventzke-Scheibler instrument, which is adapted for use with white light illumination from oil or gas lamps. Specific rotatory power as determined with reference to the ray D of the solar spectrum (sodium flame) is indicated by $[\alpha]_D$; whilst, as determined by the Ventzke-Scheibler instrument, it is indicated by $[\alpha]_j$, where j is the *transition tint* (*i.e.* from the blue to the red) and is the ray complementary to the medium yellow or *jaune moyen*—hence the *j*. This *jaune moyen* ray is the true medium yellow of the solar spectrum : its wave-length is 0·0005608 millimetres (or λ 0·0005608).

The Ventzke-Scheibler polarimeter is adjusted to the Ventzke scale, which is such that 100 divisions of the scale equal the amount of rotation caused by passing through a solution of pure cane-sugar 200 mm. in length, containing 26·048 grams of pure cane-sugar per 100 c.c. at 17·5° C. Such a solution has a sp. gr. of almost exactly 1100 (water at 17·5° C=1000). The readings for cane-sugar in this instrument consequently correspond to the sp. gr. of the solution less 1000.

Relation of $[\alpha]_j$ *to* $[\alpha]_D$.—The relation

$$[\alpha]_D : [\alpha]_j :: 21{\cdot}67^\circ : 24^\circ$$
$$:: \quad 1 \quad : 1{\cdot}107$$

holds for substances whose rotatory dispersion does not differ sensibly from that of cane-sugar. Cane-sugar, however, appears to be slightly less dispersive than maltose, dextrose, etc.: hence it has been very carefully determined by experiment* that 1·111 is the more correct factor for converting $[\alpha]_D$ into $[\alpha]_j$. We have, therefore, the following rules :—

To convert $[\alpha]_D$ into $[\alpha]_j$ multiply by 1·111 (log. 0·04571), or simply *add* one-ninth.

To convert $[\alpha]_j$ into $[\alpha]_D$ multiply by 0·900 (log. $\bar{1}$·95429), or simply *deduct* one-tenth.

Thus, if $[\alpha]_D = 202{\cdot}0$, then $[\alpha]_j = 202 + 22{\cdot}4 = 224{\cdot}4$
$[\alpha]_j = 57$, then $[\alpha]_D = 57 - 5{\cdot}7 = 51{\cdot}3$.

* See series of papers by Brown, Morris, and Millar in the *Jour. Chem. Soc.*, 1897.

SPECIFIC ROTATORY POWERS OF THE CARBOHYDRATES—*continued.*

In the Ventzke-Scheibler polarimeter 100 divisions of the scale equal 38·43° of arc or

1 scale-division = 0·3843° α_j. (log. 1·58467).

The values representing specific rotation vary directly as the sp. gr. divisor (D) used. Thus, if 150° be the specific rotation of maltose for $[\alpha]_{j\,3\cdot86}$ (that is, on the basis of the 3·86 divisor) the specific rotation where the divisor 3·93 is used must be taken as $\frac{150 \times 3\cdot93}{3\cdot86} = 152\cdot7°$.

The number of grams per 100 c.c. of a solution of a carbohydrate of which the sp. gr. (water = 1000) is known is found by dividing the sp. gr. minus 1000 by a constant given in the subjoined table. This constant is usually denoted by D.

TABLE SHOWING THE SPECIFIC ROTATORY POWERS OF THE CARBOHYDRATES.

Substance.	Formula.	Divisor to get grams per 100 c.c.*	Specific rotatory power (absolute).		Specific rotatory power reduced to the common divisor 3·86.	
		D	$[\alpha]_j$	$[\alpha]_D$	$[\alpha]_{j3\cdot86}$	$[\alpha]_{D3\cdot86}$
Dextrin	$(C_{12}H_{20}O_{10})_n$	3·95	+221	+198·9	+216	+194·4
Sucrose	$C_{12}H_{22}O_{11}$	3·85	+ 73·8	+ 66·6	+ 74	+ 66·8
Maltose	,,	3·92	+153·3	+138·0	+151	+135·9
Lactose (anhyd.)	,,	3·99	+ 61·6	+ 55·4	+ 59·6	+ 53·6
Lactose (cryst.)	$C_{12}H_{22}O_{11}.H_2O$	3·99	+ 58·5	+ 52·6	+ 56·6	+ 50·9
Dextrose	$C_6H_{12}O_6$	3·83	+ 57	+ 51·3	+ 57·4	+ 51·7
Laevulose	,,	3·93	−106 at 15·5°C.	− 95·4	−104·1 at 15·5°C.	− 93·7
Invert Sugar	$C_6H_{12}O_6 + C_6H_{12}O_6$	3·88	− 24·5 at 15·5°C.	− 22·0	− 24·4 at 15·5°C.	− 21·9

Bi-rotation.—In some cases a freshly-prepared solution of a sugar turns the plane of polarization almost twice as much as one which has been kept for some hours or heated to boiling. This phenomenon is known as *bi-rotation.*

	Multiplier.	Logarithm.
To convert $C_{12}H_{22}O_{11}$ into $C_{12}H_{24}O_{12}$	$\frac{20}{19} = 1\cdot053$	0·02228
,, $C_{12}H_{24}O_{12}$,, $C_{12}H_{22}O_{11}$	$\frac{19}{20} = 0\cdot95$	$\bar{1}$·97773
,, $C_{12}H_{20}O_{10}$,, $C_{12}H_{24}O_{12}$	$\frac{10}{9} = 1\cdot111$	0·04576
,, $C_{12}H_{24}O_{12}$,, $C_{12}H_{20}O_{10}$	$\frac{9}{10} = 0\cdot90$	$\bar{1}$·95424

* The figures given in this column are such as will be found most useful in actual work. For a complete series of absolutely correct divisors for various concentrations the valuable papers by Brown, Morris, and Millar in the *Jour. Chem. Soc.*, 1897, must be consulted.

SPECIFIC ROTATORY POWERS OF THE CARBOHYDRATES—*continued.*

1 gram in 100 c.c. of absolute	Ventzke-Scheibler Saccharimeter. Number of scale-divisions of deviation with 200 mm. tube (transition tint)*
Dextrin	+11·55
Sucrose	+ 3·84†
Maltose	+ 7·98
Dextrose	+ 2·97
Laevulose	− 5·52
Invert sugar	− 1·28
Lactose (cryst.)	+ 3·04

Formula for calculating the amount of cane-sugar present in a mixture of cane-sugar and dextrose when the specific rotatory power before and after inversion are known.

Let R_b be the specific rotatory power before inversion
R_a be the specific rotatory power after inversion
x be the percentage of cane-sugar present.

$$\text{Then} \quad 100\ R_b = 73{\cdot}8x + (100 - x)57$$
$$\text{and} \quad 100\ R_a = -24{\cdot}5x + (100 - x)57$$
$$\therefore \quad 100\ (R_b - R_a) = 98{\cdot}3x.$$
$$x = \frac{R_b - R_a}{{\cdot}983}.$$

Similarly to find the amount of cane-sugar present in a mixture of cane-sugar and dextrose from the scale degrees before and after inversion, the 200 mm. tube being used—

$$\text{Grams of cane-sugar per 100 c.c. of solution} = \frac{D_b - D_a}{5{\cdot}12}.$$

* The figures given in this column are obtained by dividing the $[\alpha]_j$ by 19·215 (log. 1·28364).

† When inverted this becomes −1·35.

Cupric Oxide Reducing Powers of the Carbohydrates.

Definition.—" Dextrose being the type of reducing bodies and the substance for which the amount of cupric oxide reduced was first determined, I use it as the standard to which to refer all other reducing carbohydrates or mixtures of reducing with non-reducing ones. I take the cupric oxide reducing power (or 'cupric reducing power') of a body or mixture to be the amount of cupric oxide, calculated as dextrose, which 100 parts reduce: it is designated by the letter K."—(*O'Sullivan*).

Briefly, we may define "K" as the specific cupric reducing power of a substance referred to dextrose as standard (100). The divisor is often added: thus $K_{3 \cdot 86}=25$ means that the cupric reducing power of the substance is one-fourth that of dextrose when the solid matter is determined by the 3·86 divisor.

Preparation of Fehling's Solution for Gravimetric Estimations.—Dissolve 34·6 grams of pure recrystallized copper sulphate in distilled water and make up the volume to 500 c.c. Then dissolve 173 grams Rochelle salt and 65 grams anhydrous sodium hydroxide in separate beakers, mix the solutions, and make up the volume with distilled water to 500 c.c. These two solutions are kept in separate bottles and are mixed in equal volumes, to form Fehling's solution, immediately before use.

Method of making an estimation of cupric reducing power.—Fifty c.c. of the freshly mixed Fehling's solution are placed in a beaker of about 250 c.c. capacity, and having a diameter of 7·5 cm. (=3 inches). This is placed in a boiling water bath, and when the solution has attained the temperature of the water, the accurately weighed or measured volume of the sugar solution is added, and the whole made up to 100 c.c. with boiling distilled water. The beaker, which is covered with a clock glass, is then returned to the water bath and the heating continued for exactly twelve minutes. The precipitated cuprous oxide is now rapidly filtered off through a Soxhlet tube, washed first with hot water, then with alcohol and ether, and finally dried. When dry, the cuprous oxide is reduced to metallic copper by gently heating in a stream of hydrogen, and weighed; or it may be oxidized in a stream of oxygen and weighed as CuO. Sometimes the Cu_2O is weighed as such, after being dried in a water oven (see O'Sullivan and Stern, *Jour. Chem. Soc.*, 1896, p. 1692).

As spontaneous reduction of Fehling's solution invariably takes place, the amount of this must be carefully determined for every fresh batch of the solution and allowed for in each determination of cupric reducing power. It usually amounts to 0·002 to 0·003 gram CuO per 50 c.c. of Fehling's solution used.

It is of great importance, in making the above estimation, that *an amount of the reducing sugar is taken that will give a weight of CuO lying between* 0·15 *and* 0·35 *gram.*

It must be carefully borne in mind that the values given in the following tables are correct only when the preparation of the

Fehling's solution, and the manner of carrying out the determination of cupric reducing power conform exactly with the directions given on p. 63. It has been shown that the amount and nature of the alkali in Fehling's solution exercises a great influence on the quantity of copper reduced by a given weight of maltose or of the starch-transformation products; but with dextrose and laevulose the influence is far less. Glendinning has proved that an equivalent amount of potassium hydroxide may be substituted for the sodium compound without causing any alteration in the reducing power. In the case of dextrose and laevulose the variant which has the greatest influence is the state of dilution of the Fehling's solution. When the dilution is greater than that prescribed in the standard method, the reducing power is appreciably lower, and the greater the dilution the greater the difference.

In the two following tables the values adopted are such as will be found to give correct results when the quantities of carbohydrates taken are those most commonly used in actual determinations.

FACTORS FOR THE DETERMINATION OF THE CARBOHYDRATES FROM THE AMOUNTS OF CuO REDUCED BY THEM OR BY THEIR EQUIVALENTS ON HYDROLYSIS.

TABLE I.—ABSOLUTE VALUES.*

K Absolute.		(Cu=63·2)	Logarithms.	1 Gram of Absolute.	(grams)	Logarithms.
	Sucrose	$=Cu \times 0·5127$	$\bar{1}$·70987	Sucrose	$=1·950$ Cu	0·29013
	,,	$=CuO \times 0·4091$	$\bar{1}$·61186	,,	$=2·444$ CuO	0·38814
	,,	$=Cu_2O \times 0·4551$	$\bar{1}$·65811	,,	$=2·197$ Cu_2O	0·34189
57·12	Maltose	$=Cu \times 0·9141$	$\bar{1}$·96097	Maltose	$=1·094$ Cu	0·03903
	,,	$=CuO \times 0·7294$	$\bar{1}$·86296	,,	$=1·371$ CuO	0·13704
	,,	$=Cu_2O \times 0·8114$	$\bar{1}$·90921	,,	$=1·233$ Cu_2O	0·09079
72·36	Lactose (anhydr.)	$=Cu \times 0·7216$	$\bar{1}$·85828	Lactose (anhydr.)	$=1·386$ Cu	0·14172
	,,	$=CuO \times 0·5758$	$\bar{1}$·76027	,,	$=1·737$ CuO	0·23973
	,,	$=Cu_2O \times 0·6405$	$\bar{1}$·80652	,,	$=1·561$ Cu_2O	0·19348
68·75	Lactose (cryst.)	$=Cu \times 0·7596$	$\bar{1}$·88056	Lactose (cryst.)	$=1·317$ Cu	0·11944
	,,	$=CuO \times 0·6061$	$\bar{1}$·78255	,,	$=1·650$ CuO	0·21745
	,,	$=Cu_2O \times 0·6742$	$\bar{1}$·82880	,,	$=1·483$ Cu_2O	0·17120
100	Dextrose	$=Cu \times 0·5222$	$\bar{1}$·71780	Dextrose	$=1·915$ Cu	0·28220
	,,	$=CuO \times 0·4167$	$\bar{1}$·61979	,,	$=2·400$ CuO	0·38021
	,,	$=Cu_2O \times 0·4635$	$\bar{1}$·66604	,,	$=2·158$ Cu_2O	0·33396
93·50	Laevulose	$=Cu \times 0·5585$	$\bar{1}$·74699	Laevulose	$=1·791$ Cu	0·25301
	,,	$=CuO \times 0·4456$	$\bar{1}$·64898	,,	$=2·244$ CuO	0·35102
	,,	$=Cu_2O \times 0·4957$	$\bar{1}$·69523	,,	$=2·017$ Cu_2O	0·30477
96·75	Invert Sugar	$=Cu \times 0·5397$	$\bar{1}$·73215	Invert Sugar	$=1·853$ Cu	0·26785
	,,	$=CuO \times 0·4307$	$\bar{1}$·63414	,,	$=2·322$ CuO	0·36586
	,,	$=Cu_2O \times 0·4791$	$\bar{1}$·68039	,,	$=2·087$ Cu_2O	0·31961
	Starch or Dextrin	$=Cu \times 0·4699$	$\bar{1}$·67204	Starch or Dextrin	$=2·128$ Cu	0·32796
	,,	$=CuO \times 0·3750$	$\bar{1}$·57403	,,	$=2·667$ CuO	0·42597
	,,	$=Cu_2O \times 0·4171$	$\bar{1}$·62028	,,	$=2·397$ Cu_2O	0·37972

* The numbers given in this table are the absolute values or the values based on the true divisor to get grams per 100 c.c. Thus 1·371 grams **CuO = 1** gram absolute maltose,—that is maltose as determined by the true divisor 3·92. For 1 gram of 3·86 maltose we should have

$$1·371 \times \frac{3·86}{3·92} = 1·350 \text{ gram CuO.}$$

Factors for the Determination of the Carbohydrates from the Amounts of CuO reduced by them or by their Equivalents on Hydrolysis.

Table II.—Values reduced to the Common Divisor (D) 3·86.

$K_{3\cdot86}$		(Cu=63·2)	Logarithms.	1 Gram of 3·86.	(grams)	Logarithms.
	Sucrose	$=Cu\ \times 0\cdot5114$	$\bar{1}\cdot70874$	Sucrose	$=1\cdot956\ Cu$	0·29126
	,,	$=CuO \times 0\cdot4081$	$\bar{1}\cdot61073$	,,	$=2\cdot451\ CuO$	0·38927
	,,	$=Cu_2O \times 0\cdot4539$	$\bar{1}\cdot65698$	,,	$=2\cdot203\ Cu_2O$	0·34302
56·25	Maltose	$=Cu\ \times 0\cdot9283$	$\bar{1}\cdot96767$	Maltose	$=1\cdot077\ Cu$	0·03233
	,,	$=CuO \times 0\cdot7407$	$\bar{1}\cdot86966$	,,	$=1\cdot350\ CuO$	0·13034
	,,	$=Cu_2O \times 0\cdot8240$	$\bar{1}\cdot91591$	,,	$=1\cdot214\ Cu_2O$	0·08409
70·01	Lactose (anhydr.)	$=Cu\ \times 0\cdot7459$	$\bar{1}\cdot87267$	Lactose (anhydr.)	$=1\cdot341\ Cu$	0·12733
	,,	$=CuO \times 0\cdot5952$	$\bar{1}\cdot77466$	,,	$=1\cdot680\ CuO$	0·22534
	,,	$=Cu_2O \times 0\cdot6621$	$\bar{1}\cdot82091$	,,	$=1\cdot510\ Cu_2O$	0·17909
66·50	Lactose (cryst.)	$=Cu\ \times 0\cdot7851$	$\bar{1}\cdot89495$	Lactose (cryst.)	$=1\cdot274\ Cu$	0·10505
	,,	$=CuO \times 0\cdot6265$	$\bar{1}\cdot79694$	,,	$=1\cdot596\ CuO$	0·20306
	,,	$=Cu_2O \times 0\cdot6969$	$\bar{1}\cdot84319$	,,	$=1\cdot435\ Cu_2O$	0·15681
100·8	Dextrose	$=Cu\ \times 0\cdot5181$	$\bar{1}\cdot71441$	Dextrose	$=1\cdot930\ Cu$	0·28559
	,,	$=CuO \times 0\cdot4134$	$\bar{1}\cdot61640$	,,	$=2\cdot419\ CuO$	0·38360
	,,	$=Cu_2O \times 0\cdot4599$	$\bar{1}\cdot66265$	,,	$=2\cdot174\ Cu_2O$	0·33735
91·83	Laevulose	$=Cu\ \times 0\cdot5686$	$\bar{1}\cdot75480$	Laevulose	$=1\cdot759\ Cu$	0·24520
	,,	$=CuO \times 0\cdot4537$	$\bar{1}\cdot65679$	,,	$=2\cdot204\ CuO$	0·34321
	,,	$=Cu_2O \times 0\cdot5047$	$\bar{1}\cdot70304$	,,	$=1\cdot981\ Cu_2O$	0·29696
96·25	Invert Sugar	$=Cu\ \times 0\cdot5425$	$\bar{1}\cdot73439$	Invert Sugar	$=1\cdot843\ Cu$	0·26561
	,,	$=CuO \times 0\cdot4329$	$\bar{1}\cdot63638$	,,	$=2\cdot310\ CuO$	0·36362
	,,	$=Cu_2O \times 0\cdot4815$	$\bar{1}\cdot68263$	,,	$=2\cdot077\ Cu_2O$	0·31737
	Starch or Dextrin	$=Cu\ \times 0\cdot4809$	$\bar{1}\cdot68205$	Starch or Dextrin	$=2\cdot079\ Cu$	0·31795
	,,	$=CuO \times 0\cdot3837$	$\bar{1}\cdot58404$	,,	$=2\cdot606\ CuO$	0·41596
	,,	$=Cu_2O \times 0\cdot4269$	$\bar{1}\cdot63029$	,,	$=2\cdot343\ Cu_2O$	0·36971

To find K *absolute* from $K_{3\cdot86}$.—Let the true divisor (D) to get grams per 100 c.c. be M, then

$$\frac{K_{3\cdot86} \times M}{3\cdot86} = K \text{ absolute.}$$

Example.—Let $K_{3\cdot86} = 61\cdot1$, and let M be 3·92, then K absolute $= \frac{61\cdot1 \times 3\cdot92}{3\cdot86} = 62\cdot05$.

TABLE FOR PHOSPHATES.

$Mg_2P_2O_7$	$Ca_3P_2O_8$	CaP_2O_6	P_2O_5	P_2	$Mg_2P_2O_7$	$Ca_3P_2O_8$	CaP_2O_6	P_2O_5	P_2
0·1	0·14	0·09	0·06	0·028	4·1	5·73	3·66	2·62	1·145
·2	0·28	0·18	0·13	0·056	·2	5·87	3·75	2·69	1·173
·3	0·42	0·27	0·19	0·084	·3	6·00	3·84	2·75	1·201
·4	0·56	0·36	0·26	0·112	·4	6·14	3·93	2·82	1·229
·5	0·70	0·45	0·32	0·140	·5	6·28	4·01	2·88	1·257
·6	0·84	0·54	0·38	0·168	·6	6·42	4·10	2·94	1·285
·7	0·98	0·62	0·45	0·196	·7	6·56	4·19	3·01	1·313
·8	1·12	0·71	0·51	0·223	·8	6·70	4·28	3·07	1·341
·9	1·26	0·80	0·58	0·251	·9	6·84	4·37	3·14	1·369
1·0	1·40	0·89	0·64	0·279	5·0	6·98	4·46	3·20	1·396
·1	1·54	0·98	0·70	0·307	·1	7·12	4·55	3·26	1·424
·2	1·68	1·07	0·77	0·335	·2	7·26	4·64	3·33	1·452
·3	1·82	1·16	0·83	0·363	·3	7·40	4·73	3·39	1·480
·4	1·96	1·25	0·90	0·391	·4	7·54	4·82	3·45	1·508
·5	2·09	1·34	0·96	0·419	·5	7·68	4·91	3·52	1·536
·6	2·23	1·43	1·02	0·447	·6	7·82	5·00	3·58	1·564
·7	2·37	1·52	1·09	0·475	·7	7·96	5·08	3·65	1·592
·8	2·51	1·61	1·15	0·503	·8	8·10	5·17	3·71	1·620
·9	2·65	1·70	1·22	0·531	·9	8·24	5·26	3·77	1·648
2·0	2·79	1·78	1·28	0·559	6·0	8·38	5·35	3·84	1·676
·1	2·93	1·87	1·34	0·587	·1	8·52	5·44	3·90	1·704
·2	3·07	1·96	1·41	0·614	·2	8·66	5·53	3·97	1·732
·3	3·21	2·05	1·47	0·642	·3	8·80	5·62	4·03	1·760
·4	3·35	2·14	1·54	0·670	·4	8·94	5·71	4·09	1·787
·5	3·49	2·23	1·60	0·698	·5	9·08	5·80	4·16	1·815
·6	3·63	2·32	1·66	0·726	·6	9·22	5·89	4·22	1·843
·7	3·77	2·41	1·73	0·754	·7	9·36	5·98	4·29	1·871
·8	3·91	2·50	1·79	0·782	·8	9·50	6·07	4·35	1·899
·9	4·05	2·59	1·86	0·810	·9	9·64	6·15	4·41	1·927
3·0	4·19	2·68	1·92	0·838	7·0	9·77	6·24	4·48	1·955
·1	4·33	2·77	1·98	0·866	·1	9·91	6·33	4·54	1·983
·2	4·47	2·85	2·05	0·894	·2	10·05	6·42	4·61	2·011
·3	4·61	2·94	2·11	0·922	·3	10·19	6·51	4·67	2·039
·4	4·75	3·03	2·18	0·950	·4	10·33	6·60	4·73	2·067
·5	4·89	3·12	2·24	0·978	·5	10·47	6·69	4·80	2·095
·6	5·03	3·21	2·30	1·006	·6	10·61	6·78	4·86	2·123
·7	5·17	3·30	2·37	1·033	·7	10·75	6·87	4·93	2·151
·8	5·31	3·39	2·43	1·061	·8	10·89	6·96	4·99	2·178
·9	5·45	3·48	2·50	1·089	·9	11·03	7·05	5·05	2·206
4·0	5·59	3·57	2·56	1·117	8·0	11·17	7·14	5·12	2·234

$Mg_2P_2O_7$	·01	·02	·03	·04	·05	·06	·07	·08	·09
$Ca_3P_2O_8$	·01	·03	·04	·06	·07	·08	·10	·11	·13
CaP_2O_6	·01	·02	·03	·04	·05	·05	·06	·07	·08
P_2O_5	·01	·01	·02	·03	·03	·04	·05	·05	·06
P_2	·003	·006	·008	·011	·014	·017	·020	·022	·025

TABLE FOR PHOSPHATES—*continued.*

$Mg_2P_2O_7$	$Ca_3P_2O_8$	CaP_2O_6	P_2O_5	P_2	$Mg_2P_2O_7$	$Ca_3P_2O_8$	CaP_2O_6	P_2O_5	P_2
8·1	11·31	7·22	5·18	2·262	12·7	17·73	11·33	8·12	3·547
·2	11·45	7·31	5·25	2·290	·8	17·87	11·42	8·19	3·575
·3	11·59	7·40	5·31	2·318	·9	18·01	11·51	8·25	3·603
·4	11·73	7·49	5·37	2·346	13·0	18·15	11·60	8·32	3·631
·5	11·87	7·58	5·44	2·374	·1	18·29	11·68	8·38	3·659
·6	12·01	7·67	5·50	2·402	·2	18·43	11·77	8·44	3·687
·7	12·15	7·76	5·57	2·430	·3	18·57	11·86	8·51	3·714
·8	12·29	7·85	5·63	2·458	·4	18·71	11·95	8·57	3·742
·9	12·43	7·94	5·69	2·486	·5	18·85	12·04	8·64	3·770
9·0	12·57	8·03	5·76	2·514	·6	18·99	12·13	8·70	3·798
·1	12·71	8·12	5·82	2·541	·7	19·13	12·22	8·76	3·826
·2	12·85	8·21	5·89	2·569	·8	19·27	12·31	8·83	3·854
·3	12·99	8·30	5·95	2·597	·9	19·41	12·40	8·89	3·882
·4	13·13	8·38	6·01	2·625	14·0	19·55	12·49	8·96	3·910
·5	13·27	8·47	6·08	2·653	·1	19·69	12·58	9·02	3·938
·6	13·41	8·56	6·14	2·681	·2	19·83	12·67	9·08	3·966
·7	13·55	8·65	6·21	2·709	·3	19·97	12·76	9·15	3·994
·8	13·69	8·74	6·27	2·737	·4	20·11	12·84	9·21	4·022
·9	13·83	8·83	6·33	2·765	·5	20·25	12·93	9·28	4·050
10·0	13·96	8·92	6·40	2·793	·6	20·39	13·02	9·34	4·078
·1	14·10	9·01	6·46	2·821	·7	20·53	13·11	9·40	4·105
·2	14·24	9·10	6·52	2·849	·8	20·67	13·20	9·47	4·133
·3	14·38	9·19	6·59	2·877	·9	20·81	13·29	9·53	4·161
·4	14·52	9·28	6·65	2·905	15·0	20·95	13·38	9·60	4·189
·5	14·66	9·37	6·72	2·932	·1	21·09	13·47	9·66	4·217
·6	14·80	9·45	6·78	2·960	·2	21·23	13·56	9·72	4·245
·7	14·94	9·54	6·84	2·988	·3	21·37	13·65	9·79	4·273
·8	15·08	9·63	6·91	3·016	·4	21·50	13·74	9·85	4·301
·9	15·22	9·72	6·97	3·044	·5	21·64	13·83	9·92	4·329
11·0	15·36	9·81	7·04	3·072	·6	21·78	13·91	9·98	4·357
·1	15·50	9·90	7·10	3·100	·7	21·92	14·00	10·04	4·385
·2	15·64	9·99	7·16	3·128	·8	22·06	14·09	10·11	4·413
·3	15·78	10·08	7·23	3·156	·9	22·20	14·18	10·17	4·441
·4	15·92	10·17	7·29	3·184	16·0	22·34	14·27	10·23	4·469
·5	16·06	10·26	7·36	3·212	·1	22·48	14·36	10·30	4·496
·6	16·20	10·35	7·42	3·240	·2	22·62	14·45	10·36	4·524
·7	16·34	10·44	7·48	3·268	·3	22·76	14·54	10·43	4·552
·8	16·48	10·53	7·55	3·296	·4	22·90	14·63	10·49	4·580
·9	16·62	10·61	7·61	3·324	·5	23·04	14·72	10·55	4·608
12·0	16·76	10·70	7·68	3·351	·6	23·18	14·81	10·62	4·636
·1	16·90	10·79	7·74	3·379	·7	23·32	14·89	10·68	4·664
·2	17·04	10·88	7·80	3·407	·8	23·46	14·98	10·75	4·692
·3	17·18	10·97	7·87	3·435	·9	23·60	15·07	10·81	4·720
·4	17·32	11·06	7·93	3·463	17·0	23·74	15·16	10·87	4·748
·5	17·46	11·15	8·00	3·491	·1	23·88	15·25	10·94	4·776
·6	17·60	11·24	8·06	3·519	·2	24·02	15·34	11·00	4·804

TABLE FOR PHOSPHATES—*continued.*

$Mg_2P_2O_7$	$Ca_3P_2O_8$	CaP_2O_6	P_2O_5	P_2	$Mg_2P_2O_7$	$Ca_3P_2O_8$	CaP_2O_6	P_2O_5	P_2
17·3	24·16	15·43	11·07	4·832	21·3	29·74	19·00	13·62	5·949
·4	24·30	15·52	11·13	4·860	·4	29·88	19·09	13·69	5·977
·5	24·44	15·61	11·19	4·887	·5	30·02	19·18	13·75	6·005
·6	24·58	15·70	11·26	4·915	·6	30·16	19·27	13·82	6·033
·7	24·72	15·79	11·32	4·943	·7	30·30	19·35	13·88	6·060
·8	24·86	15·88	11·39	4·971	·8	30·44	19·44	13·94	6·088
·9	25·00	15·97	11·45	4·999	·9	30·58	19·53	14·01	6·116
18·0	25·14	16·05	11·51	5·027	22·0	30·72	19·62	14·07	6·144
·1	25·27	16·14	11·58	5·055	·1	30·86	19·71	14·14	6·172
·2	25·41	16·23	11·64	5·083	·2	31·00	19·80	14·20	6·200
·3	25·55	16·32	11·71	5·111	·3	31·14	19·89	14·26	6·228
·4	25·69	16·41	11·77	5·139	·4	31·28	19·98	14·33	6·256
·5	25·83	16·50	11·83	5·167	·5	31·42	20·07	14·39	6·284
·6	25·97	16·59	11·90	5·195	·6	31·56	20·16	14·46	6·312
·7	26·11	16·68	11·96	5·223	·7	31·70	20·25	14·52	6·340
·8	26·25	16·77	12·03	5·250	·8	31·84	20·34	14·58	6·368
·9	26·39	16·86	12·09	5·278	·9	31·98	20·43	14·65	6·396
19·0	26·53	16·95	12·15	5·306	23·0	32·12	20·51	14·71	6·423
·1	26·67	17·04	12·22	5·334	·1	32·26	20·60	14·78	6·451
·2	26·81	17·12	12·28	5·362	·2	32·40	20·69	14·84	6·479
·3	26·95	17·21	12·35	5·390	·3	32·54	20·78	14·90	6·507
·4	27·09	17·30	12·41	5·418	·4	32·68	20·87	14·97	6·535
·5	27·23	17·39	12·47	5·446	·5	32·82	20·96	15·03	6·563
·6	27·37	17·48	12·54	5·474	·6	32·96	21·05	15·10	6·591
·7	27·51	17·57	12·60	5·502	·7	33·09	21·14	15·16	6·619
·8	27·65	17·66	12·67	5·530	·8	33·23	21·23	15·22	6·647
·9	27·79	17·75	12·73	5·558	·9	33·37	21·32	15·29	6·675
20·0	27·93	17·84	12·79	5·586	24·0	33·51	21·41	15·35	6·703
·1	28·07	17·93	12·86	5·614	·1	33·65	21·50	15·42	6·731
·2	28·21	18·02	12·92	5·642	·2	33·79	21·58	15·48	6·759
·3	28·35	18·11	12·99	5·669	·3	33·93	21·67	15·54	6·787
·4	28·49	18·20	13·05	5·697	·4	34·07	21·76	15·61	6·814
·5	28·63	18·28	13·11	5·725	·5	34·21	21·85	15·67	6·842
·6	28·77	18·37	13·18	5·753	·6	34·35	21·94	15·74	6·870
·7	28·91	18·46	13·24	5·781	·7	34·49	22·03	15·80	6·898
·8	29·05	18·55	13·31	5·809	·8	34·63	22·12	15·86	6·926
·9	29·19	18·64	13·37	5·837	·9	34·77	22·21	15·93	6·954
21·0	29·32	18·73	13·43	5·865	25·0	34·91	22·30	15·99	6·982
·1	29·46	18·82	13·50	5·893	·1	35·05	22·39	16·06	7·010
·2	29·60	18·91	13·56	5·921	·2	35·19	22·48	16·12	7·038

$Mg_2P_2O_7$	·01	·02	·03	·04	·05	·06	·07	·08	·09
$Ca_3P_2O_8$	·01	·03	·04	·06	·07	·08	·10	·11	·13
CaP_2O_6	·01	·02	·03	·04	·05	·05	·06	·07	·08
P_2O_5	·01	·01	·02	·03	·03	·04	·05	·05	·06
P_2	·003	·006	·008	·011	·014	·017	·020	·022	·025

TABLE FOR PHOSPHATES—*continued.*

$Mg_2P_2O_7$	$Ca_3P_2O_8$	CaP_2O_6	P_2O_5	P_2	$Mg_2P_2O_7$	$Ca_3P_2O_8$	CaP_2O_6	P_2O_5	P_2
25·3	35·33	22·57	16·18	7·066	29·9	41·75	26·67	19·13	8·351
·4	35·47	22·66	16·25	7·094	30·0	41·89	26·76	19·19	8·378
·5	35·61	22·74	16·31	7·122	·1	42·03	26·85	19·25	8·406
·6	35·75	22·83	16·38	7·150	·2	42·17	26·94	19·32	8·434
·7	35·89	22·92	16·44	7·178	·3	42·31	27·03	19·38	8·462
·8	36·03	23·01	16·50	7·205	·4	42·45	27·11	19·45	8·490
·9	36·17	23·10	16·57	7·233	·5	42·59	27·20	19·51	8·518
26·0	36·31	23·19	16·63	7·261	·6	42·73	27·29	19·57	8·546
·1	36·45	23·28	16·70	7·289	·7	42·87	27·38	19·64	8·574
·2	36·59	23·37	16·76	7·317	·8	43·01	27·47	19·70	8·602
·3	36·73	23·46	16·82	7·345	·9	43·15	27·56	19·77	8·630
·4	36·87	23·55	16·89	7·373	31·0	43·29	27·65	19·83	8·658
·5	37·00	23·64	16·95	7·401	·1	43·43	27·74	19·89	8·686
·6	37·14	23·72	17·02	7·429	·2	43·57	27·83	19·96	8·714
·7	37·28	23·81	17·08	7·457	·3	43·71	27·92	20·02	8·742
·8	37·42	23·90	17·14	7·485	·4	43·85	28·01	20·09	8·769
·9	37·56	23·99	17·21	7·513	·5	43·99	28·10	20·15	8·797
27·0	37·70	24·08	17·27	7·541	·6	44·13	28·18	20·21	8·825
·1	37·84	24·17	17·33	7·569	·7	44·27	28·27	20·28	8·853
·2	37·98	24·26	17·40	7·597	·8	44·41	28·36	20·34	8·881
·3	38·12	24·35	17·46	7·624	·9	44·55	28·45	20·41	8·909
·4	38·26	24·44	17·53	7·652	32·0	44·69	28·54	20·47	8·937
·5	38·40	24·53	17·59	7·680	·1	44·82	28·63	20·53	8·965
·6	38·54	24·62	17·65	7·708	·2	44·96	28·72	20·60	8·993
·7	38·68	24·71	17·72	7·736	·3	45·10	28·81	20·66	9·021
·8	38·82	24·80	17·78	7·764	·4	45·24	28·90	20·72	9·049
·9	38·96	24·88	17·85	7·792	·5	45·38	28·99	20·79	9·077
28·0	39·10	24·97	17·91	7·820	·6	45·52	29·08	20·85	9·105
·1	39·24	25·06	17·97	7·848	·7	45·66	29·17	20·92	9·133
·2	39·38	25·15	18·04	7·876	·8	45·80	29·26	20·98	9·160
·3	39·52	25·24	18·10	7·904	·9	45·94	29·34	21·04	9·188
·4	39·66	25·33	18·17	7·932	33·0	46·08	29·43	21·11	9·216
·5	39·80	25·42	18·23	7·959	·1	46·22	29·52	21·17	9·244
·6	39·94	25·51	18·29	7·987	·2	46·36	29·61	21·24	9·272
·7	40·08	25·60	18·36	8·015	·3	46·50	29·70	21·30	9·300
·8	40·22	25·69	18·42	8·043	·4	46·64	29·79	21·36	9·328
·9	40·36	25·78	18·49	8·071	·5	46·78	29·88	21·43	9·356
29·0	40·50	25·87	18·55	8·099	·6	46·92	29·97	21·49	9·384
·1	40·64	25·95	18·61	8·127	·7	47·06	30·06	21·56	9·412
·2	40·78	26·04	18·68	8·155	·8	47·20	30·15	21·62	9·440
·3	40·92	26·13	18·74	8·183	·9	47·34	30·24	21·68	9·468
·4	41·06	26·22	18·81	8·211	34·0	47·48	30·33	21·75	9·496
·5	41·19	26·31	18·87	8·239	·1	47·62	30·41	21·81	9·523
·6	41·33	26·40	18·93	8·267	·2	47·76	30·50	21·88	9·551
·7	41·47	26·49	19·00	8·295	·3	47·90	30·59	21·94	9·579
·8	41·61	26·58	19·06	8·323	·4	48·04	30·68	22·00	9·607

TABLE FOR PHOSPHATES—*continued.*

$Mg_2P_2O_7$	$Ca_3P_2O_8$	CaP_2O_6	P_2O_5	P_2	$Mg_2P_2O_7$	$Ca_3P_2O_8$	CaP_2O_6	P_2O_5	P_2
34·5	48·18	30·77	22·07	9·635	38·5	53·76	34·34	24·63	10·752
·6	48·32	30·86	22·13	9·663	·6	53·90	34·43	24·69	10·780
·7	48·46	30·95	22·20	9·691	·7	54·04	34·52	24·75	10·808
·8	48·60	31·04	22·26	9·719	·8	54·18	34·61	24·82	10·836
·9	48·74	31·13	22·32	9·747	·9	54·32	34·70	24·88	10·864
35·0	48·87	31·22	22·39	9·775	39·0	54·46	34·78	24·95	10·892
·1	49·01	31·31	22·45	9·803	·1	54·60	34·87	25·01	10·920
·2	49·15	31·40	22·52	9·831	·2	54·74	34·96	25·07	10·948
·3	49·29	31·49	22·58	9·859	·3	54·88	35·05	25·14	10·976
·4	49·43	31·57	22·64	9·887	·4	55·02	35·14	25·20	11·004
·5	49·57	31·66	22·71	9·914	·5	55·16	35·23	25·27	11·032
·6	49·71	31·75	22·77	9·942	·6	55·30	35·32	25·33	11·060
·7	49·85	31·84	22·84	9·970	·7	55·44	35·41	25·39	11·087
·8	49·99	31·93	22·90	9·998	·8	55·58	35·50	25·46	11·115
·9	50·13	32·02	22·96	10·026	·9	55·72	35·59	25·52	11·143
36·0	50·27	32·11	23·03	10·054	40·0	55·86	35·68	25·59	11·171
·1	50·41	32·20	23·09	10·082	·1	56·00	35·77	25·65	11·199
·2	50·55	32·29	23·16	10·110	·2	56·14	35·85	25·71	11·227
·3	50·69	32·38	23·22	10·138	·3	56·28	35·94	25·78	11·255
·4	50·83	32·47	23·28	10·166	·4	56·42	36·03	25·84	11·283
·5	50·97	32·55	23·35	10·194	·5	56·55	36·12	25·91	11·311
·6	51·11	32·64	23·41	10·222	·6	56·69	36·21	25·97	11·339
·7	51·25	32·73	23·48	10·250	·7	56·83	36·30	26·03	11·367
·8	51·39	32·82	23·54	10·278	·8	56·97	36·39	26·10	11·395
·9	51·53	32·91	23·60	10·306	·9	57·11	36·48	26·16	11·423
37·0	51·67	33·00	23·67	10·333	41·0	57·25	36·57	26·23	11·451
·1	51·81	33·09	23·73	10·361	·1	57·39	36·66	26·29	11·478
·2	51·95	33·18	23·80	10·389	·2	57·53	36·75	26·35	11·506
·3	52·09	33·27	23·86	10·417	·3	57·67	36·84	26·42	11·534
·4	52·23	33·36	23·92	10·445	·4	57·81	36·93	26·48	11·562
·5	52·37	33·45	23·99	10·473	·5	57·95	37·01	26·55	11·590
·6	52·51	33·54	24·05	10·501	·6	58·09	37·10	26·61	11·618
·7	52·64	33·62	24·12	10·529	·7	58·23	37·19	26·67	11·646
·8	52·78	33·71	24·18	10·557	·8	58·37	37·28	26·74	11·674
·9	52·92	33·80	24·24	10·585	·9	58·51	37·37	26·80	11·702
38·0	53·06	33·89	24·31	10·613	42·0	58·65	37·46	26·87	11·730
·1	53·20	33·98	24·37	10·641	·1	58·79	37·55	26·93	11·758
·2	53·34	34·07	24·43	10·669	·2	58·93	37·64	26·99	11·786
·3	53·48	34·16	24·50	10·696	·3	59·07	37·73	27·06	11·814
·4	53·62	34·25	24·56	10·724	·4	59·21	37·82	27·12	11·842

$Mg_2P_2O_7$	·01	·02	·03	·04	·05	·06	·07	·08	·09
$Ca_3P_2O_8$	·01	·03	·04	·06	·07	·08	·10	·11	·13
CaP_2O_6	·01	·02	·03	·04	·05	·05	·06	·07	·08
P_2O_5	·01	·01	·02	·03	·03	·04	·05	·05	·06
P_2	·003	·006	·008	·011	·014	·017	·020	·022	·025

TABLE FOR PHOSPHATES—*continued.*

$Mg_2P_2O_7$	$Ca_3P_2O_8$	CaP_2O_6	P_2O_5	P_2	$Mg_2P_2O_7$	$Ca_3P_2O_8$	CaP_2O_6	P_2O_5	P_2
42·5	59·35	37·91	27·19	11·869	47·1	65·77	42·01	30·13	13·154
·6	59·49	38·00	27·25	11·897	·2	65·91	42·10	30·19	13·182
·7	59·63	38·08	27·31	11·925	·3	66·05	42·19	30·26	13·210
·8	59·77	38·17	27·38	11·953	·4	66·19	42·28	30·32	13·238
·9	59·91	38·26	27·44	11·981	·5	66·33	42·37	30·38	13·266
43·0	60·05	38·35	27·51	12·009	·6	66·47	42·45	30·45	13·294
·1	60·18	38·44	27·57	12·037	·7	66·61	42·54	30·51	13·322
·2	60·32	38·53	27·63	12·065	·8	66·75	42·63	30·58	13·350
·3	60·46	38·62	27·70	12·093	·9	66·89	42·72	30·64	13·378
·4	60·60	38·71	27·76	12·121	48·0	67·03	42·81	30·70	13·405
·5	60·74	38·80	27·83	12·149	·1	67·17	42·90	30·77	13·433
·6	60·88	38·89	27·89	12·177	·2	67·31	42·99	30·83	13·461
·7	61·02	38·98	27·95	12·205	·3	67·45	43·08	30·90	13·489
·8	61·16	39·07	28·02	12·232	·4	67·59	43·17	30·96	13·517
·9	61·30	39·16	28·08	12·260	·5	67·73	43·26	31·02	13·545
44·0	61·44	39·24	28·14	12·288	·6	67·87	43·35	31·09	13·573
·1	61·58	39·33	28·21	12·316	·7	68·00	43·44	31·15	13·601
·2	61·72	39·42	28·27	12·344	·8	68·14	43·53	31·22	13·629
·3	61·86	39·51	28·34	12·372	·9	68·28	43·61	31·28	13·657
·4	62·00	39·60	28·40	12·400	49·0	68·42	43·70	31·34	13·685
·5	62·14	39·69	28·46	12·428	·1	68·56	43·79	31·41	13·713
·6	62·28	39·78	28·53	12·456	·2	68·70	43·88	31·47	13·741
·7	62·42	39·87	28·59	12·484	·3	68·84	43·97	31·53	13·769
·8	62·56	39·96	28·66	12·512	·4	68·98	44·06	31·60	13·796
·9	62·70	40·05	28·72	12·540	·5	69·12	44·15	31·66	13·824
45·0	62·84	40·14	28·78	12·568	·6	69·26	44·24	31·73	13·852
·1	62·98	40·23	28·85	12·596	·7	69·40	44·33	31·79	13·880
·2	63·12	40·31	28·91	12·624	·8	69·54	44·42	31·85	13·908
·3	63·26	40·40	28·98	12·651	·9	69·68	44·51	31·92	13·936
·4	63·40	40·49	29·04	12·679	50·0	69·82	44·60	31·98	13·964
·5	63·54	40·58	29·10	12·707	·1	69·96	44·68	32·05	13·992
·6	63·68	40·67	29·17	12·735	·2	70·10	44·77	32·11	14·020
·7	63·82	40·76	29·23	12·763	·3	70·24	44·86	32·17	14·048
·8	63·96	40·85	29·30	12·791	·4	70·38	44·95	32·24	14·076
·9	64·10	40·94	29·36	12·819	·5	70·52	45·04	32·30	14·104
46·0	64·23	41·03	29·42	12·847	·6	70·66	45·13	32·37	14·132
·1	64·37	41·12	29·49	12·875	·7	70·80	45·22	32·43	14·160
·2	64·51	41·21	29·55	12·903	·8	70·94	45·31	32·49	14·187
·3	64·65	41·30	29·62	12·931	·9	71·08	45·40	32·56	14·215
·4	64·79	41·38	29·68	12·959	51·0	71·22	45·49	32·62	14·243
·5	64·93	41·47	29·74	12·987	·1	71·36	45·58	32·69	14·271
·6	65·07	41·56	29·81	13·015	·2	71·50	45·67	32·75	14·299
·7	65·21	41·65	29·87	13·042	·3	71·64	45·76	32·81	14·327
·8	65·35	41·74	29·94	13·070	·4	71·78	45·84	32·88	14·355
·9	65·49	41·83	30·00	13·098	·5	71·91	45·93	32·94	14·383
47·0	65·63	41·92	30·06	13·126	·6	72·05	46·02	33·01	14·411

TABLE FOR PHOSPHATES—*continued.*

$Mg_2P_2O_7$	$Ca_3P_2O_8$	CaP_2O_6	P_2O_5	P_2	$Mg_2P_2O_7$	$Ca_3P_2O_8$	CaP_2O_6	P_2O_5	P_2
51·7	72·19	46·11	33·07	14·439	55·7	77·78	49·68	35·63	15·556
·8	72·33	46·20	33·13	14·467	·8	77·92	49·77	35·69	15·584
·9	72·47	46·29	33·20	14·495	·9	78·06	49·86	35·76	15·612
52·0	72·61	46·38	33·26	14·523	56·0	78·20	49·95	35·82	15·640
·1	72·75	46·47	33·33	14·551	·1	78·34	50·04	35·88	15·668
·2	72·89	46·56	33·39	14·579	·2	78·48	50·12	35·95	15·696
·3	73·03	46·65	33·45	14·606	·3	78·62	50·21	36·01	15·724
·4	73·17	46·74	33·52	14·634	·4	78·76	50·30	36·08	15·751
·5	73·31	46·83	33·58	14·662	·5	78·90	50·39	36·14	15·779
·6	73·45	46·91	33·65	14·690	·6	79·04	50·48	36·20	15·807
·7	73·59	47·00	33·71	14·718	·7	79·18	50·57	36·27	15·835
·8	73·73	47·09	33·77	14·746	·8	79·32	50·66	36·33	15·863
·9	73·87	47·18	33·84	14·774	·9	79·46	50·75	36·40	15·891
53·0	74·01	47·27	33·90	14·802	57·0	79·60	50·84	36·46	15·919
·1	74·15	47·36	33·97	14·830	·1	79·74	50·93	36·52	15·947
·2	74·29	47·45	34·03	14·858	·2	79·87	51·02	36·59	15·975
·3	74·43	47·54	34·09	14·886	·3	80·01	51·11	36·65	16·003
·4	74·57	47·63	34·16	14·914	·4	80·15	51·20	36·72	16·031
·5	74·71	47·72	34·22	14·941	·5	80·29	51·28	36·78	16·059
·6	74·85	47·81	34·29	14·969	·6	80·43	51·37	36·84	16·087
·7	74·99	47·90	34·35	14·997	·7	80·57	51·46	36·91	16·115
·8	75·13	47·99	34·41	15·025	·8	80·71	51·55	36·97	16·142
·9	75·27	48·07	34·48	15·053	·9	80·85	51·64	37·04	16·170
54·0	75·41	48·16	34·54	15·081	58·0	80·99	51·73	37·10	16·198
·1	75·55	48·25	34·61	15·109	·1	81·13	51·82	37·16	16·226
·2	75·69	48·34	34·67	15·137	·2	81·27	51·91	37·23	16·254
·3	75·83	48·43	34·73	15·165	·3	81·41	52·00	37·29	16·282
·4	75·97	48·52	34·80	15·193	·4	81·55	52·09	37·36	16·310
·5	76·10	48·61	34·86	15·221	·5	81·69	52·18	37·42	16·338
·6	76·24	48·70	34·93	15·249	·6	81·83	52·27	37·48	16·366
·7	76·38	48·79	34·99	15·277	·7	81·97	52·35	37·55	16·394
·8	76·52	48·88	35·05	15·305	·8	82·11	52·44	37·61	16·422
·9	76·66	48·97	35·12	15·333	·9	82·25	52·53	37·68	16·450
55·0	76·80	49·06	35·18	15·360	59·0	82·39	52·62	37·74	16·478
·1	76·94	49·14	35·24	15·388	·1	82·53	52·71	37·80	16·505
·2	77·08	49·23	35·31	15·416	·2	82·67	52·80	37·87	16·533
·3	77·22	49·32	35·37	15·444	·3	82·81	52·89	37·93	16·561
·4	77·36	49·41	35·44	15·472	·4	82·95	52·98	38·00	16·589
·5	77·50	49·50	35·50	15·500	·5	83·09	53·07	38·06	16·617
·6	77·64	49·59	35·56	15·528	·6	83·23	53·16	38·12	16·645

$Mg_2P_2O_7$	·01	·02	·03	·04	·05	·06	·07	·08	·09
$Ca_3P_2O_8$	·01	·03	·04	·06	·07	·08	·10	·11	·13
CaP_2O_6	·01	·02	·03	·04	·05	·05	·06	·07	·08
P_2O_5	·01	·01	·02	·03	·03	·04	·05	·05	·06
P_2	·003	·006	·008	·011	·014	·017	·020	·022	·025

TABLE FOR PHOSPHATES—*continued.*

$Mg_2P_2O_7$	$Ca_3P_2O_8$	CaP_2O_6	P_2O_5	P_2	$Mg_2P_2O_7$	$Ca_3P_2O_8$	CaP_2O_6	P_2O_5	P_2
59·7	83·37	53·25	38·19	16·673	61·0	85·18	54·41	39·02	17·036
·8	83·51	53·34	38·25	16·701	62	86·58	55·30	39·66	17·315
·9	83·65	53·43	38·32	16·729	63	87·97	56·19	40·30	17·595
60·0	83·78	53·51	38·38	16·757	64	89·37	57·08	40·94	17·874
·1	83·92	53·60	38·44	16·785	65	90·77	57·97	41·58	18·153
·2	84·06	53·69	38·51	16·813	66	92·16	58·87	42·22	18·433
·3	84·20	53·78	38·57	16·841	67	93·56	59·76	42·86	18·712
·4	84·34	53·87	38·63	16·869	68	94·96	60·65	43·50	18·991
·5	84·48	53·96	38·70	16·896	69	96·35	61·54	44·14	19·270
·6	84·62	54·05	38·76	16·924	70	97·75	62·43	44·78	19·550
·7	84·76	54·14	38·83	16·952	71	99·14	63·33	45·41	19·829
·8	84·90	54·23	38·89	16·980		100·00	63·87	45·81	20·000
·9	85·04	54·32	38·95	17·008					

TABLE FOR THE CONVERSION OF NITROGEN INTO AMMONIA AND ALBUMINOIDS ($=N \times 6·25$).

N.	NH_3.	Albuminoids ($N \times 6·25$).	N.	NH_3.	Albuminoids ($N \times 6·25$).	N.	NH_3.	Albuminoids ($N \times 6·25$).
0·1	0·12	0·63	1·9	2·31	11·88	3·7	4·49	23·13
·2	·24	1·25	2·0	2·43	12·50	·8	4·61	23·75
·3	·36	1·88	·1	2·55	13·13	·9	4·73	24·38
·4	·49	2·50	·2	2·67	13·75	4·0	4·86	25·00
·5	·61	3·13	·3	2·79	14·38	·1	4·98	25·63
·6	·73	3·75	·4	2·91	15·00	·2	5·10	26·25
·7	·85	4·38	·5	3·04	15·63	·3	5·22	26·88
·8	·97	5·00	·6	3·16	16·25	·4	5·34	27·50
·9	1·09	5·63	·7	3·28	16·88	·5	5·46	28·13
1·0	1·21	6·25	·8	3·40	17·50	·6	5·58	28·75
·1	1·34	6·88	·9	3·52	18·13	·7	5·71	29·38
·2	1·46	7·50	3·0	3·64	18·75	·8	5·83	30·00
·3	1·58	8·13	·1	3·76	19·38	·9	5·95	30·63
·4	1·70	8·75	·2	3·88	20·00	5·0	6·07	31·25
·5	1·82	9·38	·3	4·01	20·63	·1	6·19	31·88
·6	1·94	10·00	·4	4·13	21·25	·2	6·31	32·50
·7	2·06	10·63	·5	4·25	21·88	·3	6·43	33·13
·8	2·19	11·25	·6	4·37	22·50	·4	6·56	33·75

N	·01	·02	·03	·04	·05	·06	·07	·08	·09
NH_3	·01	·02	·04	·05	·06	·07	·09	·10	·11
Albuminoids	·06	·13	·19	·25	·31	·38	·44	·50	·56

TABLE FOR THE CONVERSION OF NITROGEN INTO AMMONIA AND ALBUMINOIDS—*continued.*

N.	NH_3.	Albuminoids (N × 6·25).	N.	NH_3.	Albuminoids (N × 6·25).	N.	NH_3.	Albuminoids (N × 6·25).
5·5	6·68	34·38	9·1	11·05	56·88	12·6	15·30	78·75
·6	6·80	35·00	·2	11·17	57·50	·7	15·42	79·38
·7	6·92	35·63	·3	11·29	58·13	·8	15·54	80·00
·8	7·04	36·25	·4	11·41	58·75	·9	15·66	80·63
·9	7·16	36·88	·5	11·53	59·38	13·0	15·78	81·25
6·0	7·28	37·50	·6	11·65	60·00	·1	15·90	81·88
·1	7·41	38·13	·7	11·78	60·63	·2	16·02	82·50
·2	7·53	38·75	·8	11·90	61·25	·3	16·15	83·13
·3	7·65	39·38	·9	12·02	61·88	·4	16·27	83·75
·4	7·77	40·00	10·0	12·14	62·50	·5	16·39	84·38
·5	7·89	40·63	·1	12·26	63·13	·6	16·51	85·00
·6	8·01	41·25	·2	12·38	63·75	·7	16·63	85·63
·7	8 13	41·88	·3	12·50	64·38	·8	16·75	86·25
·8	8·26	42·50	·4	12·63	65·00	·9	16·87	86·88
·9	8·38	43 13	·5	12·75	65·63	14·0	17·00	87·50
7·0	8·50	43·75	·6	12·87	66·25	·1	17·12	88·13
·1	8·62	44·38	·7	12·99	66·88	·2	17·24	88·75
·2	8·74	45·00	·8	13·11	67·50	·3	17·36	89·38
·3	8·86	45·63	·9	13·23	68·13	·4	17·48	90·00
·4	8·98	46·25	11·0	13·35	68·75	·5	17·60	90·63
·5	9·11	46·88	·1	13·48	69·38	·6	17·72	91·25
·6	9·23	47 50	·2	13·60	70·00	·7	17·85	91·88
·7	9·35	48 13	·3	13·72	70·63	·8	17·97	92·50
·8	9·47	48 75	·4	13·84	71·25	·9	18·09	93·13
·9	9·59	49 38	·5	13·96	71·88	15·0	18·21	93·75
8·0	9·71	50·00	·6	14·08	72·50	·1	18·33	94·38
·1	9·83	50·63	·7	14·20	73·13	·2	18·45	95·00
·2	9·95	51·25	·8	14·33	73·75	·3	18·57	95·63
·3	10·08	51·88	·9	14·45	74·38	·4	18·70	96·25
·4	10·20	52·50	12·0	14·57	75·00	·5	18·82	96·88
·5	10·32	53·13	·1	14·69	75·63	·6	18·94	97·50
·6	10·44	53·75	·2	14·81	76·25	·7	19·06	98·13
·7	10·56	54·38	·3	14·93	76·88	·8	19·18	98·75
·8	10·68	55·00	·4	15·05	77·50	·9	19·31	99·38
·9	10·80	55·63	·5	15·18	78·13	16·0	19·43	100·00
9·0	10·93	56·25						

N	·01	·02	·03	·04	·05	·06	·07	·08	·09
NH_3	·01	·02	·04	·05	·06	·07	·09	·10	·11
Albuminoids	·06	·13	·19	·25	·31	·38	·44	·50	·56

Table for Kjeldahl Process: 1 Gram of Substance being Used.

1 c.c. $\frac{N}{5}$ acid = ·0028 gram N = ·0034 gram NH_3.

No. of c.c. $\frac{N}{5}$ acid used.	% N.	% NH_3.	No. of c.c. $\frac{N}{5}$ acid used.	% N.	% NH_3.	No. of c.c. $\frac{N}{5}$ acid used.	% N.	% NH_3.
1	0·28	0·34	21	5·88	7·14	41	11·48	13·94
2	0·56	0·68	22	6·16	7·48	42	11·76	14·28
3	0·84	1·02	23	6·44	7·82	43	12·04	14·62
4	1·12	1·36	24	6·72	8·16	44	12·32	14·96
5	1·40	1·70	25	7·00	8·50	45	12·60	15·30
6	1·68	2·04	26	7·28	8·84	46	12·88	15·64
7	1·96	2·38	27	7·56	9·18	47	13·16	15·98
8	2·24	2·72	28	7·84	9·52	48	13·44	16·32
9	2·52	3·06	29	8·12	9·86	49	13·72	16·66
10	2·80	3·40	30	8·40	10·20	50	14·00	17·00
11	3·08	3·74	31	8·68	10·54	51	14·28	17·34
12	3·36	4·08	32	8·96	10·88	52	14·56	17·68
13	3·64	4·42	33	9·24	11·22	53	14·84	18·02
14	3·92	4·76	34	9·52	11·56	54	15·12	18·36
15	4·20	5·10	35	9·80	11·90	55	15·40	18·70
16	4·48	5·44	36	10·08	12·24	56	15·68	19·04
17	4·76	5·78	37	10·36	12·58	57	15·96	19·38
18	5·04	6·12	38	10·64	12·92	58	16·24	19·72
19	5·32	6·46	39	10·92	13·26	59	16·52	20·06
20	5·60	6·80	40	11·20	13·60	60	16·80	20·40

C.c. $\frac{N}{5}$ acid	0·1	0·2	0·3	0·4	0·5	0·6	0·7	0·8	0·9
% N	·03	·06	·08	·11	·14	·17	·20	·22	·25
% NH_3	·03	·07	·10	·14	·17	·20	·24	·27	·31

log. ·0028 = $\bar{3}$·44716.
log. ·0034 = $\bar{3}$·53148.

Note on Crystallized Quinine Sulphate.

When crystallized quinine sulphate is freely exposed to air at the ordinary temperature, it rapidly effloresces until it attains the composition of a sulphate containing 2 (instead of 7½) molecules of water, or 4·6 per cent. This air-dried sulphate has the following composition:—

	Molecular Weight.	Per Cent.
$(C_{20}H_{24}N_2O_2)_2$ . .	648	82·87
H_2SO_4 . . .	98	12·53
$2H_2O$ . . .	36	4·60
	782	100·00

Freshly crystallized quinine sulphate contains 7½ molecules of water of crystallization, which are expelled at a temperature of 100° C. When the dehydrated sulphate is freely exposed to air at the ordinary temperature, it rapidly absorbs water until it has the composition of a sulphate with 2 molecules of water; but when access of air is retarded, the amount of water of crystallization in the salt is variable, and bears no constant relation to the dry sulphate until 2 molecules of water have been absorbed.—(A. J. Cownley in *Pharm. Jour.*, 19th Dec. 1896.)

QUININE.

Hydrochlorate of Quinine, $C_{20}H_{24}N_2O_2$, HCl, $2OH_2$. $=324+36\cdot5+36=396\cdot5$ Percentage composition.		Sulphate of Quinine, $2[(C_{20}H_{24}N_2O_2)_2.H_2SO_4]$, $15OH_2$. $=1296+196+270=1762$ Percentage composition.	
$C_{20}H_{24}N_2O_2$	81·715	$C_{20}H_{24}N_2O_2$	73·55
HCl	9·205	H_2SO_4	11·12
OH_2	9·080	OH_2	15·33
	100·000		100·00

To convert	Multiplier.	Log. to be added.
$C_{20}H_{24}N_2O_2$ into $C_{20}H_{24}N_2O_2$, HCl, $2OH_2$	1·224	0·087 6982
,, ,, $2[(C_{20}H_{24}N_2O_2)_2.H_2SO_4]$, $15OH_2$	1·360	0·133 4009
Grams of Quinine per fluid drachm into grains of Hydrochlorate of Quinine per fluid ounce	151·09	2·179 2203

Tincture of Quinine, B.P., contains 8 grains of hydrochlorate of quinine in the fluid ounce.

E. W. T. JONES'S METHOD FOR THE ESTIMATION OF CHICORY IN MIXTURES OF COFFEE AND CHICORY.

The sample is dried in the water-oven, and 5 grams are weighed into a large porcelain dish. About 200 c.c. of water are added, and boiled for 15 minutes. After allowing a minute or two for settling, the liquid is strained through a piece of copper gauze placed in a funnel into a 250 c.c. measuring flask, care being taken to disturb the grounds as little as possible. The latter are now treated with about 50 c.c. of water, boiled for 5 minutes, and the liquid strained off as before. The flask is then cooled, made up to the mark, well agitated and filtered, the liquid being poured on a *dry* filter; 50 c.c. of the filtrate (=1 gram of the coffee mixture) are then pipetted into a weighed, flat-bottomed glass dish, evaporated to dryness over a steam-bath, and finally dried in the water-oven. The results are returned to the nearest percentage of chicory (see Table on p. 74).

Treated as above, chicory gives a mean percentage extract of 70; while coffee gives a remarkably constant percentage extract of 24.

To determine the percentage of chicory from the weight of extract obtained, we proceed as follows:—

Let x = percentage of chicory.
$\therefore 100-x=$,, coffee.
and let E = ,, extract found.

$$\therefore 0\cdot7x+\cdot24(100-x)=E.$$
$$0\cdot7x+24-\cdot24x=E.$$
$$\cdot46x=E-24.$$
$$x=\frac{E-24.}{\cdot46}$$

Putting $x=1$, we find $E=24\cdot46$, and the table on page 74 is in this way easily calculated.

Table showing the Percentage of Chicory with Coffee from the Percentage of Aqueous Extract.

Extract per cent.	Chicory per cent.	Extract per cent.	Chicory per cent.	Extract per cent.	Chicory per cent.
24·46	1	40·10	35	55·28	68
·92	2	·56	36	·74	69
25·38	3	41·02	37	56·20	70
·84	4	·48	38	·66	71
26·30	5	·94	39	57·12	72
·76	6	42·40	40	·58	73
27·22	7	·86	41	58·04	74
·68	8	43·32	42	·50	75
28·14	9	·78	43	·96	76
·60	10	44·24	44	59·42	77
29·06	11	·70	45	·88	78
·52	12	45·16	46	60·34	79
·98	13	·62	47	·80	80
30·44	14	46·08	48	61·26	81
·90	15	·54	49	·72	82
31·36	16	47·00	50	62·18	83
·82	17	·46	51	·64	84
32·28	18	·92	52	63·10	85
·74	19	48·38	53	·56	86
33·20	20	·84	54	64·02	87
·66	21	49·30	55	·48	88
34·12	22	·76	56	·94	89
·58	23	50·22	57	65·40	90
35·04	24	·68	58	·86	91
·50	25	51·14	59	66·32	92
·96	26	·60	60	·78	93
36·42	27	52·06	61	67·24	94
·88	28	·52	62	·70	95
37·34	29	·98	63	68·16	96
·80	30	53·44	64	·62	97
38·26	31	·90	65	69·08	98
·72	32	54·36	66	·54	99
39·18	33	·82	67	70·00	100
·64	34				

BAUMÉ'S HYDROMETER.—*Table for Liquids heavier than Water.**

° B.	° Tw.	Sp. gr.	° B.	° Tw.	Sp. gr.	° B.	° Tw.	Sp. gr.
1	1·4	1·007	23	38	1·190	45	90·6	1·453
2	2·8	1·014	24	40	1·200	46	93·6	1·468
3	4·4	1·022	25	42	1·210	47	96·6	1·483
4	5·8	1·029	26	44	1·220	48	99·6	1·498
5	7·4	1·037	27	46·2	1·231	49	103	1·515
6	9	1·045	28	48·2	1·241	50	106	1·530
7	10·2	1·052	29	50·4	1·252	51	109·2	1·546
8	12	1·060	30	52·6	1·263	52	112·6	1·563
9	13·4	1·067	31	54·8	1·274	53	116	1·580
10	15	1·075	32	57	1·285	54	119·4	1·597
11	16·6	1·083	33	59·4	1·297	55	123	1·615
12	18·2	1·091	34	61·6	1·308	56	127	1·635
13	20	1·100	35	64	1·320	57	130·4	1·652
14	21·6	1·108	36	66·4	1·332	58	134·2	1·671
15	23·2	1·116	37	69	1·345	59	138·2	1·691
16	25	1·125	38	71·4	1·357	60	142	1·710
17	26·8	1·134	39	74	1·370	61	146·4	1·732
18	28·4	1·142	40	76·6	1·383	62	150·6	1·753
19	30·4	1·152	41	79·4	1·397	63	155	1·775
20	32·4	1·162	42	82	1·410	64	159	1·795
21	34·2	1·171	43	84·8	1·424	65	164	1·820
22	36	1·180	44	87·6	1·438	66	168·4	1·842

* This is the Baumé's hydrometer mostly used on the Continent of Europe; but other scales are in use there as well, and quite another scale for Baumé's hydrometer is used in America (Lunge & Hurter, *Alkali Makers' Handbook*).

Table for Liquids lighter than Water.

° B.	Sp. gr.	° B.	Sp. gr.	° B.	Sp. gr.
10	1·000	27	0·896	44	0·811
11	0·993	28	0·890	45	0·807
12	0·986	29	0·885	46	0·802
13	0·980	30	0·880	47	0·798
14	0·973	31	0·874	48	0·794
15	0·967	32	0·869	49	0·789
16	0·960	33	0·864	50	6·785
17	0·954	34	0·859	51	0·781
18	0·948	35	0·854	52	0·777
19	0·942	36	0·849	53	0·773
20	0·936	37	0·844	54	0·768
21	0·930	38	0·839	55	0·764
22	0·924	39	0·834	56	0·760
23	0·918	40	0·830	57	0·757
24	0·913	41	0·825	58	0·753
25	0·907	42	0·820	59	0·749
26	0·901	43	0·816	60	0·745

Twaddell's Hydrometer.—To convert degrees Twaddell into specific gravity (water = 1000): multiply the number by 5, and add 1000 to the product.

To reduce specific gravity (water = 1000) to Twaddell: deduct 1000, and divide the remainder by 5

ALCOHOL TABLE.

Sp. gr. at 60° F.	Per cent. of Alcohol by weight.	Per cent. of Alcohol by volume.	Per cent. *under* Proof.	Sp. gr. at 60° F.	Per cent. of Alcohol by weight.	Per cent. of Alcohol by volume.	Per cent. *under* Proof.
1·0000	0·00	0·00	100·00	·9775	15·25	18·78	67·10
·9995	0·26	0·33	99·42	·9770	15·67	19·28	66·20
·9990	0·53	0·66	98·84	·9765	16·08	19·78	65·34
·9985	0·79	0·99	98·26	·9760	16·46	20·24	64·53
·9980	1·06	1·34	97·66	·9755	16·85	20·71	63·72
·9975	1·37	1·73	96·97	·9750	17·25	21·19	62·87
·9970	1·69	2·12	96·29	·9745	17·67	21·69	62·00
·9965	2·00	2·51	95·60	·9740	18·08	22·18	61·13
·9960	2·28	2·86	95·00	·9735	18·46	22·64	60·32
·9955	2·56	3·21	94·40	·9730	18·85	23·10	59·52
·9950	2·83	3·55	93·78	·9725	19·25	23·58	58·67
·9945	3·12	3·90	93·16	·9720	19·67	24·08	57·80
·9940	3·41	4·27	92·50	·9715	20·08	24·58	56·93
·9935	3·71	4·63	91·87	·9710	20·50	25·07	56·06
·9930	4·00	5·00	91·23	·9705	20·92	25·57	55·20
·9925	4·31	5·39	90·55	·9700	21·31	26·04	54·37
·9920	4·62	5·78	89·87	·9695	21·69	26·49	53·57
·9915	4·94	6·17	89·20	·9690	22·08	26·95	52·77
·9910	5·25	6·55	88·50	·9685	22·46	27·40	51·98
·9905	5·56	6·94	87·84	·9680	22·85	27·86	51·18
·9900	5·87	7·32	87·16	·9675	23·23	28·31	50·38
·9895	6·21	7·74	86·43	·9670	23·62	28·77	49·60
·9890	6·57	8·18	85·65	·9665	24·00	29·22	48·80
·9885	6·93	8·63	84·88	·9660	24·38	29·67	48·00
·9880	7·27	9·04	84·15	·9655	24·77	30·13	47·20
·9875	7·60	9·45	83·43	·9650	25·14	30·57	46·44
·9870	7·93	9·86	82·70	·9645	25·50	30·98	45·70
·9865	8·29	10·30	81·96	·9640	25·86	31·40	44·97
·9860	8·64	10·73	81·20	·9635	26·20	31·80	44·27
·9855	9·00	11·17	80·42	·9630	26·53	32·19	43·60
·9850	9·36	11·61	79·65	·9625	26·87	32·58	42·90
·9845	9·71	12·05	78·90	·9620	27·21	32·98	42·20
·9840	10·08	12·49	78·10	·9615	27·57	33·39	41·47
·9835	10·46	12·96	77·30	·9610	27·93	33·81	40·74
·9830	10·85	13·43	76·46	·9605	28·25	34·18	40·10
·9825	11·23	13·90	75·64	·9600	28·56	34·54	39·47
·9820	11·62	14·37	74·82	·9595	28·87	34·90	38·84
·9815	12·00	14·84	74·00	·9590	29·20	35·28	38·18
·9810	12·38	15·30	73·18	·9585	29·53	35·66	37·50
·9805	12·77	15·77	72·36	·9580	29·87	36·04	36·83
·9800	13·15	16·24	71·54	·9575	30·17	36·39	36·23
·9795	13·54	16·70	70·73	·9570	30·44	36·70	35·68
·9790	13·92	17·17	69·90	·9565	30·72	37·02	35·13
·9785	14·36	17·70	68·97	·9560	31·00	37·34	34·57
·9780	14·82	18·25	68·00	·9555	31·31	37·69	33·95

ALCOHOL TABLE—*continued.*

Sp. gr. at 60° F.	Per cent. of Alcohol by weight.	Per cent. of Alcohol by volume.	Per cent. *under* Proof.	Sp. gr. at 60° F.	Per cent. of Alcohol by weight.	Per cent. of Alcohol by volume.	Per cent. *under* Proof.
·9550	31·62	38·04	33·32	·9325	43·48	51·07	10·50
·9545	31·94	38·40	32·70	·9320	43·71	51·32	10·05
·9540	32·25	38·75	32·08	·9315	43·95	51·58	9·60
·9535	32·56	39·11	31·46	·9310	44·18	51·82	9·20
·9530	32·87	39·47	30·84	·9305	44·41	52·06	8·77
·9525	33·18	39·81	30·24	·9300	44·64	52·29	8·36
·9520	33·47	40·14	29·66	·9295	44·86	52·53	7·94
·9515	33·76	40·47	29·08	·9290	45·09	52·77	7·52
·9510	34·05	40·79	28·52	·9285	45·32	53·01	7·10
·9505	34·29	41·05	28·06	·9280	45·55	53·24	6·70
·9500	34·52	41·32	27·60	·9275	45·77	53·48	6·27
·9495	34·76	41·58	27·13	·9270	46·00	53·72	5·86
·9490	35·00	41·84	26·67	·9265	46·23	53·95	5·45
·9485	35·25	42·12	26·20	·9260	46·46	54·19	5·03
·9480	35·50	42·40	25·70	·9255	46·68	54·43	4·62
·9475	35·75	42·67	25·22	·9250	46·91	54·66	4·20
·9470	36·00	42·95	24·74	·9245	47·14	54·90	3·80
·9465	36·28	43·26	24·20	·9240	47·36	55·13	3·38
·9460	36·56	43·56	23·66	·9235	47·59	55·37	2·97
·9455	36·83	43·87	23·12	·9230	47·82	55·60	2·56
·9450	37·11	44·18	22·58	·9225	48·05	55·83	2·15
·9445	37·39	44·49	22·04	·9220	48·27	56·07	1·74
·9440	37·67	44·79	21·50	·9215	48·50	56·30	1·33
·9435	37·94	45·10	20·96	·9210	48·73	56·54	0·92
·9430	38·22	45·41	20·43	·9205	48·96	56·77	0·50
·9425	38·50	45·71	19·89	·9200	49·16	56·98	0·14
·9420	38·78	46·02	19·36	·9198	49·24	57·06	Proof
·9415	39·05	46·32	18·83	·9195	49·39	57·20	0·25
·9410	39·30	46·59	18·36	·9190	49·64	57·45	0·68
·9405	39·55	46·86	17·88	·9185	49·86	57·69	1·10
·9400	39·80	47·13	17·40	·9180	50·09	57·92	1·51
·9395	40·05	47·40	16·93	·9175	50·30	58·14	1·89
·9390	40·30	47·67	16·46	·9170	50·52	58·36	2·28
·9385	40·55	47·94	15·98	·9165	50·74	58·58	2·66
·9380	40·80	48·21	15·50	·9160	50·96	58·80	3·05
·9375	41·05	48·48	15·04	·9155	51·17	59·01	3·41
·9370	41·30	48·75	14·57	·9150	51·38	59·22	3·78
·9365	41·55	49·02	14·10	·9145	51·58	59·43	4·14
·9360	41·80	49·29	13·63	·9140	51·79	59·63	4·50
·9355	42·05	49·55	13·16	·9135	52·00	59·84	4·87
·9350	42·29	49·81	12·70	·9130	52·23	60·07	5·27
·9345	42·52	50·06	12·27	·9125	52·45	60·30	5·67
·9340	42·76	50·31	11·82	·9120	52·68	60·52	6·07
·9335	43·00	50·57	11·38	·9115	52·91	60·74	6·47
·9330	43·24	50·82	10·94	·9110	53·13	60·97	6·86

ALCOHOL TABLE—*continued.*

Sp. gr. at 60° F.	Per cent. of Alcohol by weight.	Per cent. of Alcohol by volume.	Per cent. *over* Proof.	Sp. gr. at 60° F.	Per cent. of Alcohol by weight.	Per cent. of Alcohol by volume.	Per cent. *over* Proof.
·9105	53·35	61·19	7·23	·8880	63·26	70·77	24·02
·9100	53·57	61·40	7·61	·8875	63·48	70·97	24·37
·9095	53·78	61·62	7·99	·8870	63·70	71·17	24·73
·9090	54·00	61·84	8·36	·8865	63·91	71·38	25·09
·9085	54·24	62·07	8·78	·8860	64·13	71·58	25·44
·9080	54·48	62·31	9·20	·8855	64·35	71·78	25·79
·9075	54·71	62·55	9·62	·8850	64·57	71·98	26·15
·9070	54·95	62·79	10·03	·8845	64·78	72·18	26·50
·9065	55·18	63·02	10·44	·8840	65·00	72·38	26·85
·9060	55·41	63·24	10·84	·8835	65·21	72·58	27·19
·9055	55·64	63·46	11·24	·8830	65·42	72·77	27·52
·9050	55·86	63·69	11·64	·8825	65·63	72·96	27·85
·9045	56·09	63·91	12·03	·8820	65·83	73·15	28·19
·9040	56·32	64·14	12·41	·8815	66·04	73·34	28·52
·9035	56·55	64·36	12·80	·8810	66·26	73·54	28·87
·9030	56·77	64·58	13·18	·8805	66·48	73·73	29·22
·9025	57·00	64·80	13·57	·8800	66·70	73·93	29·57
·9020	57·22	65·01	13·92	·8795	66·91	74·13	29·92
·9015	57·42	65·21	14·27	·8790	67·13	74·33	30·26
·9010	57·63	65·41	14·62	·8785	67·33	74·52	30·59
·9005	57·83	65·61	14·97	·8780	67·54	74·70	30·92
·9000	58·05	65·81	15·33	·8775	67·75	74·89	31·25
·8995	58·27	66·03	15·72	·8770	67·96	75·08	31·58
·8990	58·50	66·25	16·11	·8765	68·17	75·27	31·90
·8985	58·73	66·47	16·49	·8760	68·38	75·45	32·23
·8980	58·95	66·69	16·88	·8755	68·58	75·64	32·56
·8975	59·17	66·90	17·25	·8750	68·79	75·83	32·89
·8970	59·39	67·11	17·61	·8745	69·00	76·01	33·21
·8965	59·61	67·32	17·98	·8740	69·21	76·20	33·54
·8960	59·83	67·53	18·34	·8735	69·42	76·39	33·86
·8955	60·04	67·73	18·70	·8730	69·63	76·57	34·19
·8950	60·26	67·93	19·05	·8725	69·83	76·76	34·51
·8945	60·46	68·13	19·39	·8720	70·04	76·94	34·84
·8940	60·67	68·33	19·74	·8715	70·24	77·12	35·14
·8935	60·88	68·52	20·08	·8710	70·44	77·29	35·45
·8930	61·08	68·72	20·42	·8705	70·64	77·46	35·76
·8925	61·29	68·91	20·77	·8700	70·84	77·64	36·07
·8920	61·50	69·11	21·11	·8695	71·04	77·82	36·37
·8915	61·71	69·30	21·45	·8690	71·25	78·00	36·69
·8910	61·92	69·50	21·79	·8685	71·46	78·18	37·01
·8905	62·14	69·71	22·16	·8680	71·67	78·36	37·33
·8900	62·36	69·92	22·53	·8675	71·88	78·55	37·65
·8895	62·59	70·14	22·91	·8670	72·09	78·73	37·98
·8890	62·82	70·35	23·29	·8665	72·30	78·93	38·32
·8885	63·04	70·57	23·66	·8660	72·52	79·12	38·65

ALCOHOL TABLE—*continued.*

Sp. gr. at 60° F.	Per cent. of Alcohol by weight.	Per cent. of Alcohol by volume.	Per cent. *over* Proof.	Sp. gr. at 60° F.	Per cent. of Alcohol by weight.	Per cent. of Alcohol by volume.	Per cent. *over* Proof.
·8655	72·74	79·31	38·99	·8430	82·15	87·24	52·90
·8650	72·96	79·50	39·32	·8425	82·35	87·40	53·16
·8645	73·17	79·68	39·64	·8420	82·54	87·55	53·43
·8640	73·38	79·86	39·96	·8415	82·73	87·70	53·70
·8635	73·58	80·04	40·27	·8410	82·92	87·85	53·96
·8630	73·79	80·22	40·60	·8405	83·12	88·00	54·23
·8625	74·00	80·40	40·91	·8400	83·31	88·16	54·50
·8620	74·23	80·60	41·26	·8395	83·50	88·31	54·75
·8615	74·45	80·80	41·61	·8390	83·69	88·46	55·02
·8610	74·68	81·00	41·96	·8385	83·88	88·61	55·28
·8605	74·91	81·20	42·31	·8380	84·08	88·76	55·55
·8600	75·14	81·40	42·66	·8375	84·28	88·92	55·83
·8595	75·36	81·60	43·00	·8370	84·48	89·08	56·10
·8590	75·59	81·80	43·35	·8365	84·68	89·24	56·38
·8585	75·82	82·00	43·70	·8360	84·88	89·39	56·66
·8580	76·04	82·19	44·04	·8355	85·08	89·55	56·93
·8575	76·25	82·37	44·35	·8350	85·27	89·70	57·20
·8570	76·46	82·54	44·66	·8345	85·46	89·84	57·45
·8565	76·67	82·72	44·97	·8340	85·65	89·99	57·71
·8560	76·88	82·90	45·28	·8335	85·85	90·14	57·97
·8555	77·08	83·07	45·60	·8330	86·04	90·29	58·23
·8550	77·29	83·25	45·90	·8325	86·23	90·43	58·48
·8545	77·50	83·43	46·20	·8320	86·42	90·58	58·74
·8540	77·71	83·60	46·51	·8315	86·62	90·73	59·00
·8535	77·92	83·78	46·82	·8310	86·81	90·88	59·26
·8530	78·12	83·94	47·11	·8305	87·00	91·02	59·51
·8525	78·32	84·11	47·40	·8300	87·19	91·17	59·77
·8520	78·52	84·27	47·70	·8295	87·38	91·31	60·02
·8515	78·72	84·44	47·98	·8290	87·58	91·46	60·28
·8510	78·92	84·60	48·27	·8285	87·77	91·60	60·53
·8505	79·12	84·77	48·56	·8280	87·96	91·75	60·79
·8500	79·32	84·93	48·84	·8275	88·16	91·90	61·05
·8495	79·52	85·10	49·13	·8270	88·36	92·05	61·32
·8490	79·72	85·26	49·38	·8265	88·56	92·21	61·60
·8485	79·92	85·42	49·67	·8260	88·76	92·36	61·86
·8480	80·13	85·59	50·00	·8255	88·96	92·51	62·12
·8475	80·33	85·77	50·31	·8250	89·16	92·66	62·38
·8470	80·54	85·94	50·61	·8245	89·35	92·80	62·63
·8465	80·75	86·11	50·91	·8240	89·54	92·94	62·88
·8460	80·96	86·28	51·21	·8235	89·73	93·09	63·13
·8455	81·16	86·45	51·50	·8230	89·92	93·23	63·38
·8450	81·36	86·61	51·78	·8225	90·11	93·36	63·62
·8445	81·56	86·77	52·06	·8220	90·29	93·49	63·84
·8440	81·76	86·93	52·34	·8215	90·46	93·62	64·06
·8435	81·96	87·09	52·62	·8210	90·64	93·75	64·30

ALCOHOL TABLE—*continued.*

Sp. gr. at 60° F.	Per cent. of Alcohol by weight.	Per cent. of Alcohol by volume.	Per cent. *over* Proof.	Sp. gr. at 60° F.	Per cent. of Alcohol by weight.	Per cent. of Alcohol by volume.	Per cent. *over* Proof.
·8205	90·82	93·87	64·51	·8065	95·86	97·39	70·67
·8200	91·00	94·00	64·74	·8060	96·03	97·51	70·88
·8195	91·18	94·13	64·96	·8055	96·20	97·62	71·07
·8190	91·36	94·26	65·18	·8050	96·37	97·73	71·26
·8185	91·54	94·38	65·40	·8045	96·53	97·83	71·45
·8180	91·71	94·51	65·62	·8040	96·70	97·94	71·64
·8175	91·89	94·64	65·85	·8035	96·87	98·05	71·83
·8170	92·07	94·76	66·07	·8030	97·03	98·16	72·02
·8165	92·26	94·90	66·30	·8025	97·20	98·27	72·20
·8160	92·44	95·03	66·53	·8020	97·37	98·37	72·40
·8155	92·63	95·16	66·76	·8015	97·53	98·48	72·58
·8150	92·81	95·29	67·00	·8010	97·70	98·59	72·77
·8145	93·00	95·42	67·23	·8005	97·87	98·69	72·95
·8140	93·18	95·55	67·46	·8000	98·03	98·80	73·14
·8135	93·37	95·69	67·70	·7995	98·19	98·89	73·30
·8130	93·55	95·82	67·92	·7990	98·34	98·98	73·47
·8125	93·74	95·95	68·15	·7985	98·50	99·07	73·64
·8120	93·92	96·08	68·38	·7980	98·66	99·16	73·81
·8115	94·10	96·20	68·60	·7975	98·81	99·26	73·97
·8110	94·28	96·32	68·80	·7970	98·97	99·35	74·14
·8105	94·45	96·43	69·00	·7965	99·13	99·45	74·31
·8100	94·62	96·55	69·20	·7960	99·29	99·55	74·50
·8095	94·80	96·67	69·40	·7955	99·45	99·65	74·66
·8090	94·97	96·78	69·61	·7950	99·61	99·75	74·83
·8085	95·14	96·90	69·82	·7945	99·78	99·86	75·01
·8080	95·32	97·02	70·03	·7940	99·94	99·96	75·18
·8075	95·50	97·15	70·25		Absolute	Alcohol	
·8070	95·68	97·27	70·46	·7938	100·00	100·00	75·25

According to the provisions of "The Sale of Food and Drugs Act, 1875," Brandy, Whisky, and Rum may be 25° U.P. and Gin 35° U.P.

25° U.P. = 0·9473 sp. gr., 35·85 per cent. alcohol, by weight; 42·78 per cent. alcohol by volume.

35° U.P. = 0·9564 sp. gr., 30·78 per cent. alcohol by weight; 37·08 per cent. alcohol by volume.

"Rectified spirit, B.P.," is alcohol with 16 per cent. water. sp. gr. 0·8380; 55°·55 over Proof. It contains 84·08 per cent. by weight and 88·76 per cent. by volume of alcohol.

"Proof spirit" has the sp. gr. 0·9198. It contains 49·24 per cent. by weight and 57·06 per. cent. by volume of alcohol.

Simple rules for finding the percentages of added water in the case of diluted spirits.

I. Brandy, Whisky, or Rum (25° U. P. allowed).

Let a sample be N° U. P.

Therefore in 100 volumes we have N volumes of water, and (100 – N) volumes of proof-spirit.

Let x be the percentage of water by volume added to spirit of 25° U. P. to produce a sample N° U. P. Then equating amounts of water we have—

$$(100-x)\frac{25}{100}+x=\text{N}.$$

$$25-\frac{x}{4}+x=\text{N}.$$

$$\frac{3}{4}x=\text{N}-25.$$

$$x=\frac{4(\text{N}-25)}{3}.$$

Hence we have the following rule :—

To get percentage of added water by volume in the case of diluted brandy, whisky, or rum, increase the excess of degrees U. P. above 25 by one-third.

II. Gin (35° U. P. allowed).

Reasoning exactly as in I., we have—

$$(100-x_1)\frac{35}{100}+x_1=\text{N}_1.$$

$$35-\frac{7}{20}x_1+x_1=\text{N}_1.$$

$$\frac{13}{20}x_1=\text{N}_1-35.$$

$$x_1=\frac{20}{13}(\text{N}_1-35).$$

$$x_1=1{\cdot}54(\text{N}_1-35).$$

Hence the rule :—

To get percentage of added water by volume in diluted gin, multiply the excess of degrees U. P. above 35 by 1·54.

*** The above rules I owe to Mr E. W. T. Jones, who discovered them empirically and used them simply for checking results obtained by the usual method of calculation from the percentage of alcohol present. The proofs I have given above established the accuracy of Rule I., and gave the correct factor 1·54 in Rule II. in place of the 1½ previously used for checking.—*A. E. J.*

Correction of Specific Gravity of Dilute Alcohol for Temperature.

Specific Gravity.	1° Fah.	1° C.	Specific Gravity.	1° Fah.	1° C.
·794–·864	0·00046	0·00083	·965– ·966	0·00026	0·00047
·864–·889	45	81	·966– ·967	25	45
·889–·902	44	79	·967– ·968	24	43
·902–·912	43	77	·968– ·969	23	41
·912–·921	42	76	·969– ·970	22	40
·921–·928	41	74	·970– ·971	21	38
·928–·935	40	72	·971– ·973	20	36
·935–·940	39	70	·973– ·974	19	34
·940–·943	38	68	·974– ·975	18	32
·943–·946	37	67	·975– ·976	17	31
·946–·949	36	65	·976– ·977	16	29
·949–·951	35	63	·977– ·978	15	27
·951–·953	34	61	·978– ·980	14	25
·953–·955	33	59	·980– ·981	13	23
·955–·957	32	58	·981– ·983	12	22
·957–·959	31	56	·983– ·985	11	20
·959–·961	30	54	·985– ·987	10	18
·961–·962	29	52	·987– ·990	·00009	16
·962–·963	28	50	·990– ·995	8	14
·963–·965	27	49	·995–1·000	7	13

Rule.—To obtain correct sp. gr. at 60° Fah. (=15·5° C.), multiply the factor given in the table opposite to the observed sp. gr. by the difference in temperature, and *add* if the recorded temperature is *above* 60° F., or *substract* if it is *below* 60°.

Ex.—The sp. gr. at 60° Fah. of dilute alcohol of sp. gr. 0·952 at 64° Fah. is $0·952+(0·00034\times4)=0·95336$.

Various Methods of stating Alcoholic Strengths.

Based on Squibb's absolute alcohol of sp. gr. 0·7935,

Proof spirit containing 49·2 % of this alcohol, and having a sp. gr. of 0·9198,

and using c.c. to indicate the volume of 1 gram of water at 60° F., we have the formulæ given below.

Let S = sp. gr. at 60°/60° F.

% = grams of absolute alcohol per 100 grams.

v/v = c.c. absolute alcohol per 100 c.c.

w/v = grams of absolute alcohol per 100 c.c.

P = c.c. proof spirit per 100 c.c.

then

$$\% = \frac{v/v \times ·7935}{S} = \frac{w/v}{S} = \frac{P \times ·4525}{S}$$

$$v/v = \% \times 1·262\ S = 1·262\ w/v = 0·5703\ P$$

$$w/v = \% \times S = ·7935\ v/v = 0·4525\ P$$

$$P = \% \times 2·21\ S = 1·753\ v/v = 2·21\ w/v$$

grains per fluid ounce = $w/v \times 4·3756$.

OTTO'S TABLE SHOWING THE PERCENTAGES OF H_2SO_4 CORRESPONDING TO THE DILUTE ACID OF VARIOUS SPECIFIC GRAVITIES AT 15° C.

Per cent. of H_2SO_4.	Specific Gravity.	Per cent. of H_2SO_4.	Specific Gravity.	Per cent. of H_2SO_4.	Specific Gravity.	Per cent. of H_2SO_4.	Specific Gravity.
100	1·8426	75	1·6750	50	1·3980	25	1·1820
99	1·8420	74	1·6630	49	1·3866	24	1·1740
98	1·8406	73	1·6510	48	1·3790	23	1·1670
97	1·8400	72	1·6390	47	1·3700	22	1·1590
96	1·8384	71	1·6270	46	1·3610	21	1·1516
95	1·8376	70	1·6150	45	1·3510	20	1·1440
94	1·8356	69	1·6040	44	1·3420	19	1·1360
93	1·8340	68	1·5920	43	1·3330	18	1·1290
92	1·8310	67	1·5800	42	1·3240	17	1·1210
91	1·8270	66	1·5860	41	1·3150	16	1·1136
90	1·8220	65	1·5570	40	1·3060	15	1·1060
89	1·8160	64	1·5450	39	1·2976	14	1·0980
88	1·8090	63	1·5340	38	1·2890	13	1·0910
87	1·8020	62	1·5230	37	1·2810	12	1·0830
86	1·7940	61	1·5120	36	1·2720	11	1·0756
85	1·7860	60	1·5010	35	1·2640	10	1·0680
84	1·7770	59	1·4900	34	1·2560	9	1·0610
83	1·7670	58	1·4800	33	1·2476	8	1·0536
82	1·7560	57	1·4690	32	1·2390	7	1·0464
81	1·7450	56	1·4586	31	1·2310	6	1·0390
80	1·7340	55	1·4480	30	1·2230	5	1·0320
79	1·7220	54	1·4380	29	1·2150	4	1·0256
78	1·7100	53	1·4280	28	1·2066	3	1·0190
77	1·6980	52	1·4180	27	1·1980	2	1·0130
76	1·6860	51	1·4080	26	1·1900	1	1·0064

TABLE SHOWING THE STRENGTH OF HCl OF DIFFERENT SPECIFIC GRAVITIES AT 15° C. (DR URE.)

Specific Gravity.	Per cent. of HCl	Per cent. of Acid of 1·20 sp. gr.	Specific Gravity.	Per cent. of HCl	Per cent. of Acid of 1·20 sp. gr.	Specific Gravity.	Per cent. of HCl	Per cent. of Acid of 1·20 sp. gr.
1·2000	40·777	100	1·1857	37·516	92	1·1701	34·252	84
1·1982	40·369	99	1·1846	37·108	91	1·1681	33·845	83
1·1964	39·961	98	1·1822	36·700	90	1·1661	33·437	82
1·1946	39·554	97	1·1802	36·292	89	1·1641	33·029	81
1·1928	39·146	96	1·1782	35·884	88	1·1620	32·621	80
1·1910	38·738	95	1·1762	35·476	87	1·1599	32·213	79
1·1893	38·330	94	1·1741	35·068	86	1·1578	31·805	78
1·1875	37·923	93	1·1721	34·660	85	1·1557	31·398	77

Table showing the Strength of HCl of different Specific Gravities at 15° C.—*continued.*

Specific Gravity.	Per cent. of HCl	Per cent. of Acid of 1·20 sp. gr.	Specific Gravity.	Per cent. of HCl	Per cent. of Acid of 1·20 sp. gr.	Specific Gravity.	Per cent. of HCl	Per cent. of Acid of 1·20 sp. gr.
1·1536	30·990	76	1·1000	20·388	50	1·0477	9·786	24
1·1515	30·582	75	1·0980	19·980	49	1·0457	9·379	23
1·1494	30·174	74	1·0960	19·572	48	1·0437	8·971	22
1·1473	29·767	73	1·0939	19·165	47	1·0417	8·563	21
1·1452	29·359	72	1·0919	18·757	46	1·0397	8·155	20
1·1431	28·951	71	1·0899	18·349	45	1·0377	7·747	19
1·1410	28·544	70	1·0879	17·941	44	1·0357	7·340	18
1·1389	28·136	69	1·0859	17·534	43	1·0337	6·932	17
1·1369	27·728	68	1·0838	17·126	42	1·0318	6·524	16
1·1349	27·321	67	1·0818	16·718	41	1·0298	6·116	15
1·1328	26·913	66	1·0798	16·310	40	1·0279	5·709	14
1·1308	26·505	65	1·0778	15·902	39	1·0259	5·301	13
1·1287	26·098	64	1·0758	15·494	38	1·0239	4·893	12
1·1267	25·690	63	1·0738	15·087	37	1·0220	4·486	11
1·1247	25·282	62	1·0718	14·679	36	1·0200	4·078	10
1·1226	24·847	61	1·0697	14·271	35	1·0180	3·670	9
1·1206	24·466	60	1·0677	13·863	34	1·0160	3·262	8
1·1185	24·058	59	1·0657	13·456	33	1·0140	2·854	7
1·1164	23·650	58	1·0637	13·049	32	1·0120	2·447	6
1·1143	23·242	57	1·0617	12·641	31	1·0100	2·039	5
1·1123	22·834	56	1·0597	12·233	30	1·0080	1·631	4
1·1102	22·426	55	1·0577	11·825	29	1·0060	1·224	3
1·1082	22·019	54	1·0557	11·418	28	1·0040	·816	2
1·1061	21·611	53	1·0537	11·010	27	1·0020	·408	1
1·1041	21·203	52	1·0517	10·602	26			
1·1020	20·796	51	1·0497	10·194	25			

Table showing the Strength of HNO_3 of various Specific Gravities.

The numbers marked * are the results of direct observations ; the others are obtained by interpolation.

HNO_3 per cent.	Specific Gravity		HNO_3 per cent.	Specific Gravity		HNO_3 per cent.	Specific Gravity	
	At 0°	At 15°		At 0°	At 15°		At 0°	At 15°
100·00	1·559	1·530	93·01*	1·533*	1·506*	84·00	1·499	1·474
99·84*	1·559*	1·530*	92·00	1·529	1·503	83·00	1·495	1·470
99·72*	1·558*	1·530*	91·00	1·526	1·499	82·00	1·492	1·467
99·52*	1·557*	1·529*	90·00	1·522	1·495	80·96*	1·488*	1·463*
97·89*	1·551*	1·523*	89·56*	1·521*	1·494*	80·00	1·484	1·460
97·00	1·548	1·520	88·00	1·514	1·488	79·00	1·481	1·456
96·00	1·544	1·516	87·45*	1·513*	1·486*	77·66	1·476	1·451
95·27*	1·542*	1·514*	86·17*	1·507*	1·482*	76·00	1·469	1·445
94·00	1·537	1·509	85·00	1·503	1·478	75·00	1·465	1·442

TABLE SHOWING THE STRENGTH OF HNO_3 OF VARIOUS SPECIFIC GRAVITIES—*continued.*

HNO_3 per cent.	Specific Gravity		HNO_3 per cent.	Specific Gravity		HNO_3 per cent.	Specific Gravity	
	At 0°	At 15°		At 0°	At 15°		At 0°	At 15°
74·01*	1·462*	1·438*	55·00	1·365	1·346	33·86*	1·226*	1·211*
73·00	1·457	1·435	54·00	1·359	1·341	32·00	1·214	1·198
72·39*	1·455*	1·432*	53·81	1·358	1·339	31·00	1·207	1·192
71·24*	1·450*	1·429*	53·00	1·353	1·335	30·00	1·200	1·185
69·96	1·444	1·423	52·33*	1·349*	1·331*	29·00	1·194	1·179
69·20*	1·441	1·419*	50·99*	1·341*	1·323*	28·00*	1·187*	1·172*
68·00	1·435	1·414	49·97	1·334	1·317	27·00	1·180	1·166
67·00	1·430	1·410	49·00	1·328	1·312	25·71*	1·171*	1·157*
66·00	1·425	1·405	48·00	1·321	1·304	23·00	1·153	1·138
65·07*	1·420*	1·400*	47·18*	1·315*	1·298*	20·00	1·132	1·120
64·00	1·415	1·395	46·64	1·312	1·295	17·47*	1·115*	1·105*
63·59	1·413	1·393	45·00	1·300	1·284	15·00	1·099	1·089
62·00	1·404	1·386	43·53*	1·291*	1·274*	13·00	1·085	1·077
61·21*	1·400*	1·381*	42·00	1·280	1·264	11·41*	1·075	1·067*
60·00	1·393	1·374	41·00	1·274	1·257	7·22*	1·050	1·045*
59·59*	1·391*	1·372*	40·00	1·267	1·251	4·00	1·026	1·022
58·88	1·387	1·368	39·00	1·260	1·244	2·00	1·013	1·010
58·00	1·382	1·363	37·95*	1·253*	1·237*	0·00	1·000	0·999
57·00	1·376	1·358	36·00	1·240	1·225			
56·10*	1·371*	1·353*	35·00	1·234	1·218			

TABLE SHOWING THE PERCENTAGE OF K_2O AND KHO IN SOLUTIONS OF CAUSTIC POTASH OF VARIOUS SPECIFIC GRAVITIES AT 15° C.*

Per cent. of K_2O	Per cent. of KHO	Specific Gravity.	Per cent. of K_2O	Per cent. of KHO	Specific Gravity.
·5658	0·674	1·0050	23·764	28·303	1·2648
1·697	2·021	1·0153	24·895	29·650	1·2805
2·829	3·369	1·0260	26·027	30·998	1·2966
3·961	4·717	1·0369	27·158	32·345	1·3131
5·002	5·957	1·0478	28·290	33·693	1·3300
6·224	7·412	1·0589	29·34	34·94	1·30
7·355	8·760	1·0703	30·74	36·61	1·32
8·487	10·108	1·0819	32·14	38·28	1·34
9·619	11·456	1·0938	33·46	39·85	1·36
10·750	12·803	1·1059	34·74	41·37	1·38
11·882	14·151	1·1182	35·99	42·86	1·40
13·013	15·498	1·1308	37·97	45·22	1·42
14·145	16·846	1·1437	40·17	47·84	1·44
15·277	18·195	1·1568	42·31	50·39	1·46
16·408	19·542	1·1702	44·40	52·88	1·48
17·540	20·890	1·1839	46·45	55·32	1·50
18·671	22·237	1·1979	48·46	57·71	1·52
19·803	23·585	1·2122	50·09	59·65	1·54
20·935	24·933	1·2268	51·58	61·43	1·56
21·500	25·606	1·2342	53·06	63·19	1·58
22·632	26·954	1·2493			

* Tünnermann and Richter.

TABLE SHOWING THE PERCENTAGE OF Na_2O IN SOLUTIONS OF CAUSTIC SODA OF VARIOUS SPECIFIC GRAVITIES AT 15° C.*

Per cent. of Na_2O	Specific Gravity.	Per cent. of Na_2O	Specific Gravity.	Per cent. of Na_2O	Specific Gravity.
·302	1·0040	10·879	1·1630	21·154	1·3053
·604	1·0081	11·484	1·1734	21·758	1·3125
1·209	1·0163	12·088	1·1841	21·894	1·3143
1·813	1·0246	12·692	1·1948	22·363	1·3198
2·418	1·0330	13·297	1·2058	22·967	1·3273
3·022	1·0414	13·901	1·2178	23·572	1·3349
3·626	1·0500	14·506	1·2280	24·176	1·3426
4·231	1·0587	15·110	1·2392	24·780	1·3505
4·835	1·0675	15·714	1·2453	25·385	1·3586
5·440	1·0764	16·319	1·2515	25·989	1·3668
6·044	1·0855	16·923	1·2578	26·594	1·3751
6·648	1·0948	17·528	1·2642	27·200	1·3836
7·253	1·1042	18·132	1·2708	27·802	1·3923
7·857	1·1137	18·730	1·2775	28·407	1·4011
8·462	1·1233	19·341	1·2843	29·011	1·4101
9·066	1·1330	19·945	1·2912	29·616	1·4193
9·670	1·1428	20·550	1·2982	30·220	1·4285
10·275	1·1528				

TABLE SHOWING THE PERCENTAGE OF NH_3 IN AQUEOUS SOLUTIONS OF THE GAS OF VARIOUS SPECIFIC GRAVITIES AT 14° C. (CARIUS.)

Specific Gravity.	NH_3 per cent.	Specific Gravity.	NH_3 per cent.	Specific Gravity.	NH_3 per cent.
0·8844	36	0·9133	24	0·9520	12
0·8864	35	0·9162	23	0·9556	11
0·8885	34	0·9191	22	0·9593	10
0·8907	33	0·9221	21	0·9631	9
0·8929	32	0·9251	20	0·9670	8
0·8953	31	0·9283	19	0·9709	7
0·8976	30	0·9314	18	0·9749	6
0·9001	29	0·9347	17	0·9790	5
0·9026	28	0·9380	16	0·9831	4
0·9052	27	0·9414	15	0·9873	3
0·9078	26	0·9449	14	0·9915	2
0·9106	25	0·9484	13	0·9959	1

RULES FOR THE CONVERSION OF THERMOMETRIC DEGREES FROM ONE SCALE INTO ANOTHER.

To Convert	Rules.
° F. into ° C.	First subtract 32, then multiply by 5 and divide by 9.
° F. into ° R.	First subtract 32, then multiply by 4 and divide by 9.
° C. into ° F.	Multiply by 9 and divide by 5, then add 32.
° C. into ° R.	Multiply by 4 and divide by 5.
° R. into ° F.	Multiply by 9 and divide by 4, then add 32.
° R. into ° C.	Multiply by 5 and divide by 4.

* Tünnermann.

Conversion of the different Thermometric Scales.

Table I.

Fahr.	Reaum.	Cent.	Fahr.	Reaum.	Cent.	Fahr.	Reaum.	Cent.
500	208	260	452	186·7	233·3	404	165·3	206·7
499	207·6	259·4	451	186·2	232·8	403	164·9	206·1
498	207·1	258·9	450	185·8	232·2	402	164·4	205·6
497	206·7	258·3	449	185·3	231·7	401	164	205
496	206·2	257·8	448	184·9	231·1	400	163·6	204·4
495	205·8	257·2	447	184·4	230·6	399	163·1	203·9
494	205·3	256·7	446	184	230	398	162·7	203·3
493	204·9	256·1	445	183·6	229·4	397	162·2	202·8
492	204·4	255·6	444	183·1	228·9	396	161·8	202·2
491	204	255	443	182·7	228·3	395	161·3	201·7
490	203·6	254·4	442	182·2	227·8	394	160·9	201·1
489	203·1	253·9	441	181·8	227·2	393	160·4	200·6
488	202·7	253·3	440	181·3	226·7	392	160	200
487	202·2	252·8	439	180·9	226·1	391	159·6	199·4
486	201·8	252·2	438	180·4	225·6	390	159·1	198·9
485	201·3	251·7	437	180	225	389	158·7	198·3
484	200·9	251·1	436	179·6	224·4	388	158·2	197·8
483	200·4	250·6	435	179·1	223·9	387	157·8	197·2
482	200	250	434	178·7	223·3	386	157·3	196·7
481	199·6	249·4	433	178·2	222·8	385	156·9	196·1
480	199·1	248·9	432	177·8	222·2	384	156·4	195·6
479	198·7	248·3	431	177·3	221·7	383	156	195
478	198·2	247·8	430	176·9	221·1	382	155·6	194·4
477	197·8	247·2	429	176·4	220·6	381	155·1	193·9
476	197·3	246·7	428	176	220	380	154·7	193·3
475	196·9	246·1	427	175·6	219·4	379	154·2	192·8
474	196·4	245·6	426	175·1	218·9	378	153·8	192·2
473	196	245	425	174·7	218·3	377	153·3	191·7
472	195·6	244·4	424	174·2	217·8	376	152·9	191·1
471	195·1	243·9	423	173·8	217·2	375	152·4	190·6
470	194·7	243·3	422	173·3	216·7	374	152	190
469	194·2	242·8	421	172·9	216·1	373	151·6	189·4
468	193·8	242·2	420	172·4	215·6	372	151·1	188·9
467	193·3	241·7	419	172	215	371	150·7	188·3
466	192·9	241·1	418	171·6	214·4	370	150·2	187·8
465	192·4	240·6	417	171·1	213·9	369	149·8	187·2
464	192	240	416	170·7	213·3	368	149·3	186·7
463	191·6	239·4	415	170·2	212·8	367	148·9	186·1
462	191·1	238·9	414	169·8	212·2	366	148·4	185·6
461	190·7	238·3	413	169·3	211·7	365	148	185
460	190·2	237·8	412	168·9	211·1	364	147·6	184·4
459	189·8	237·2	411	168·4	210·6	363	147·1	183·9
458	189·3	236·7	410	168	210	362	146·7	183·3
457	188·9	236·1	409	167·6	209·4	361	146·2	182·8
456	188·4	235·6	408	167·1	208·9	360	145·8	182·2
455	188	235	407	166·7	208·3	359	145·3	181·7
454	187·6	234·4	406	166·2	207·8	358	144·9	181·1
453	187·1	233·9	405	165·8	207·2	357	144·4	180·6

Conversion of the different Thermometric Scales.

Table I.—*continued.*

Fahr.	Reaum.	Cent.	Fahr.	Reaum.	Cent.	Fahr.	Reaum.	Cent.
356	144	180	308	122·7	153·3	260	101·3	126·7
355	143·6	179 4	307	122·2	152·8	259	100·9	126·1
354	143·1	178·9	306	121·8	152·2	258	100·4	125·6
353	142·7	178·3	305	121·3	151·7	257	100	125
352	142·2	177·8	304	120·9	151·1	256	99·6	124·4
351	141·8	177·2	303	120·4	150·6	255	99·1	123·9
350	141·3	176·7	302	120	150	254	98·7	123·3
349	140·9	176·1	301	119·6	149·4	253	98·2	122·8
348	140·4	175·6	300	119·1	148·9	252	97·8	122·2
347	140	175	299	118·7	148·3	251	97·3	121·7
346	139·6	174·4	298	118·2	147·8	250	96·9	121·1
345	139·1	173·9	297	117·8	147·2	249	96·4	120·6
344	138·7	173·3	296	117·3	146·7	248	96	120
343	138·2	172·8	295	116·9	146·1	247	95·6	119·4
342	137·8	172·2	294	116·4	145·6	246	95·1	118·9
341	137·3	171·7	293	116	145	245	94·7	118·3
340	136·9	171·1	292	115·6	144·4	244	94·2	117·8
339	136·4	170·6	291	115·1	143·9	243	93·8	117·2
338	136	170	290	114·7	143·3	242	93·3	116·7
337	135·6	169·4	289	114·2	142·8	241	92·9	116·1
336	135·1	168·9	288	113·8	142·2	240	92·4	115·6
335	134·7	168·3	287	113·3	141·7	239	92	115
334	134·2	167·8	286	112·9	141·1	238	91·6	114·4
333	133·8	167·2	285	112·4	140·6	237	91·1	113·9
332	133·3	166·7	284	112	140	236	90·7	113·3
331	132·9	166·1	283	111·6	139·4	235	90·2	112·8
330	132·4	165·6	282	111·1	138·9	234	89·8	112·2
329	132	165	281	110·7	138·3	233	89·3	111·7
328	131·6	164·4	280	110·2	137·8	232	88·9	111·1
327	131·1	163·9	279	109·8	137·2	231	88·4	110·6
326	130·7	163·3	278	109·3	136·7	230	88	110
325	130·2	162·8	277	108·9	136·1	229	87·6	109·4
324	129·8	162·2	276	108·4	135·6	228	87·1	108·9
323	129·3	161·7	275	108	135	227	86·7	108·3
322	128·9	161·1	274	107·6	134·4	226	86·2	107·8
321	128·4	160·6	273	107·1	133·9	225	85·8	107·2
320	128	160	272	106·7	133·3	224	85·3	106·7
319	127·6	159·4	271	106·2	132·8	223	84·9	106·1
318	127·1	158·9	270	105·8	132·2	222	84·4	105·6
317	126·7	158·3	269	105·3	131·7	221	84	105
316	126·2	157·8	268	104·9	131·1	220	83·6	104·4
315	125·8	157·2	267	104·4	130·6	219	83·1	103·9
314	125·3	156·7	266	104	130	218	82·7	103·3
313	124·9	156·1	265	103·6	129·4	217	82·2	102·8
312	124·4	155·6	264	103·1	128·9	216	81·8	102·2
311	124	155	263	102·7	128·3	215	81·3	101·7
310	123·6	154·4	262	102·2	127·8	214	80·9	101·1
309	123·1	153·9	261	101·8	127·2	213	80·4	100·6

CONVERSION OF THE DIFFERENT THERMOMETRIC SCALES.

TABLE I.—*continued.*

FAHR.	Reaum.	Cent.	FAHR.	Reaum.	ent·	FAHR.	Reaum.	Cent.
212	80·0	100·0	164	58·7	73·3	116	37·3	46·7
211	79·6	99·4	163	58·2	72·8	115	36·9	46·1
210	79·1	98·9	162	57·8	72·2	114	36·4	45·6
209	78·7	98·3	161	57·3	71·7	113	36·0	45·0
208	78·2	97·8	160	56·9	71·1	112	35·6	44·4
207	77·8	97·2	159	56·4	70·6	111	35·1	43·9
206	77·3	96·7	158	56·0	70·0	110	34·7	43·3
205	76·9	96·1	157	55·6	69·4	109	34·2	42·8
204	76·4	95·6	156	55·1	68·9	108	33·8	42·2
203	76·0	95·0	155	54·7	68·3	107	33·3	41·7
202	75·6	94·4	154	54·2	67·8	106	32·9	41·1
201	75·1	93·9	153	53·8	67·2	105	32·4	40·6
200	74·7	93·3	152	53·3	66·7	104	32·0	40·0
199	74·2	92·8	151	52·9	66·1	103	31·6	39·4
198	73·8	92·2	150	52·4	65·6	102	31·1	38·9
197	73·3	91·7	149	52·0	65·0	101	30·7	38·3
196	72·9	91·1	148	51·6	64·4	100	30·2	37·8
195	72·4	90·6	147	51·1	63·9	99	29·8	37·2
194	72·0	90·0	146	50·7	63·3	98	29·3	36·7
193	71·6	89·4	145	50·2	62·8	97	28·9	36·1
192	71·1	88·9	144	49·8	62·2	96	28·4	35·6
191	70·7	88·3	143	49·3	61·7	95	28·0	35·0
190	70·2	87·8	142	48·9	61·1	94	27·6	34·4
189	69·8	87·2	141	48·4	60·6	93	27·1	33·9
188	69·3	86·7	140	48·0	60·0	92	26·7	33·3
187	68·9	86·1	139	47·6	59·4	91	26·2	32·8
186	68·4	85·6	138	47·1	58·9	90	25·8	32·2
185	68·0	85·0	137	46·7	58·3	89	25·3	31·7
184	67·6	84·4	136	46·2	57·8	88	24·9	31·1
183	67·1	83·9	135	45·8	57·2	87	24·4	30·6
182	66·7	83·3	134	45·3	56·7	86	24·0	30·0
181	66·2	82·8	133	44·9	56·1	85	23·6	29·4
180	65·8	82·2	132	44·4	55·6	84	23·1	28·9
179	65·3	81·7	131	44·0	55·0	83	22·7	28·3
178	64·9	81·1	130	43·6	54·4	82	22·2	27·8
177	64·4	80·6	129	43·1	53·9	81	21·8	27·2
176	64·0	80·0	128	42·7	53·3	80	21·3	26·7
175	63·6	79·4	127	42·2	52·8	79	20·9	26·1
174	63·1	78·9	126	41·8	52·2	78	20·4	25·6
173	62·7	78·3	125	41·3	51·7	77	20·0	25·0
172	62·2	77·8	124	40·9	51·1	76	19·6	24·4
171	61·8	77·2	123	40·4	50·6	75	19·1	23·9
170	61·3	76·7	122	40·0	50·0	74	18·7	23·3
169	60·9	76·1	121	39·6	49·4	73	18·2	22·8
168	60·4	75·6	120	39·1	48·9	72	17·8	22·2
167	60·0	75·0	119	38·7	48·3	71	17·3	21·7
166	59·6	74·4	118	38·2	47·8	70	16·9	21·1
165	59·1	73·9	117	37·8	47·2	69	16·4	20·6

Conversion of the different Thermometric Scales.

Table I.—*continued.*

Fahr.	Reaum.	Cent.	Fahr.	Reaum.	Cent.	Fahr.	Reaum.	Cent.
68	16·0	20·0	34	0·9	1·1	0	−14·2	−17·8
67	15·6	19·4	33	0·4	0·6	− 1	−14·7	−18·3
66	15·1	18·9	32	0·0	0·0	− 2	−15·1	−18·9
65	14·7	18·3	31	− 0·4	− 0·6	− 3	−15·6	−19·4
64	14·2	17·8	30	− 0·9	− 1·1	− 4	−16·0	−20·0
63	13·8	17·2	29	− 1·3	− 1·7	− 5	−16·4	−20·6
62	13·3	16·7	28	− 1·8	− 2·2	− 6	−16·9	−21·1
61	12·9	16·1	27	− 2·2	− 2·8	− 7	−17·3	−21·7
60	12·4	15·6	26	− 2·7	− 3·3	− 8	−17·8	−22·2
59	12·0	15·0	25	− 3·1	− 3·9	− 9	−18·2	−22·8
58	11·6	14·4	24	− 3·6	− 4·4	−10	−18·7	−23·3
57	11·1	13·9	32	− 4·0	− 5·0	−11	−19·1	−23·9
56	10·7	13·3	22	− 4·4	− 5·6	−12	−19·6	−24·4
55	10·2	12·8	21	− 4·9	− 6·1	−13	−20·0	−25·0
54	9·8	12·2	20	− 5·3	− 6·7	−14	−20·4	−25·6
53	9·3	11·7	19	− 5·8	− 7·2	−15	−20·9	−26·1
52	8·9	11·1	18	− 6·2	− 7·8	−16	−21·3	−26·7
51	8·4	10·6	17	− 6·7	− 8·3	−17	−21·8	−27·2
50	8·0	10·0	16	− 7·1	− 8·9	−18	−22·2	−27·8
49	7·6	9·4	15	− 7·6	− 9·5	−19	−22·7	−28·3
48	7·1	8·9	14	− 8·0	−10·0	−20	−23·1	−28·9
47	6·7	8·3	13	− 8·4	−10·6	−21	−23·6	−29·4
46	6·2	7·8	12	− 8·9	−11·1	−22	−24·0	−30·0
45	5·8	7·2	11	− 9·3	−11·7	−23	−24·4	−30·6
44	5·3	6·7	10	− 9·8	−12·2	−24	−24·9	−31·1
43	4·9	6·1	9	−10·2	−12·8	−25	−25·3	−31·7
42	4·4	5·6	8	−10·7	−13·3	−26	−25·8	−32·2
41	4·0	5·0	7	−11·1	−13·9	−27	−26·2	−32·8
40	3·6	4·4	6	−11·6	−14·4	−28	−26·7	−33·3
39	3·1	3·9	5	−12·0	−15·0	−29	−27·1	−33·9
38	2·7	3·3	4	−12·4	−15·6	−30	−27·6	−34·4
37	2·2	2·8	3	−12·9	−16·1	−31	−28·0	−35·0
36	1·8	2·2	2	−13·3	−16·7			
35	1·3	1·7	1	−13·8	−17·2			

Conversion of the different Thermometric Scales.

Table II.

Cent.	Reaum.	Fahr.	Cent.	Reaum.	Fahr.	Cent.	Reaum.	Fahr.
260	208	500	252	201·6	485·6	244	195·2	471·2
259	207·2	498·2	251	200·8	483·8	243	194·4	469·4
258	206·4	496·4	250	200	482	242	193·6	467·6
257	205·6	494·6	249	199·2	480·2	241	192·8	465·8
256	204·8	492·8	248	198·4	478·4	240	192	464
255	204	491	247	197·6	476·6	239	191·2	462·2
254	203·2	489·2	246	196·8	474·8	238	190·4	460·4
253	202·4	487·4	245	196	473	237	189·6	458·6

Conversion of the different Thermometric Scales.

Table II.—*continued.*

Cent.	Reaum.	Fahr.	Cent.	Reaum.	Fahr.	Cent.	Reaum.	Fahr.
236	188·8	456·8	188	150·4	370·4	140	112	284
235	188	455	187	149·6	368·6	139	111·2	282·2
234	187·2	453·2	186	148·8	366·8	138	110·4	280·4
233	186·4	451·4	185	148	365	137	109·6	278·6
232	185·6	449·6	184	147·2	363·2	136	108·8	276·8
231	184·8	447·8	183	146·4	361·4	135	108	275
230	184	446	182	145·6	359·6	134	107·2	273·2
229	183·2	444·2	181	144·8	357·8	133	106·4	271·4
228	182·4	442·4	180	144	356	132	105·6	269·6
227	181·6	440·6	179	143·2	354·2	131	104·8	267·8
226	180·8	438·8	178	142·4	352·4	130	104	266
225	180	437	177	141·6	350·6	129	103·2	264·2
224	179·2	435·2	176	140·8	348·8	128	102·4	262·4
223	178·4	433·4	175	140	347	127	101·6	260·6
222	177·6	431·6	174	139·2	345·2	126	100·8	258·8
221	176·8	429·8	173	138·4	343·4	125	100	257
220	176	428	172	137·6	341·6	124	99·2	255·2
219	175·2	426·2	171	136·8	339·8	123	98·4	253·4
218	174·4	424·4	170	136	338	122	97·6	251·6
217	173·6	422·6	169	135·2	336·2	121	96·8	249·8
216	172·8	420·8	168	134·4	334·4	120	96	248
215	172	419	167	133·6	332·6	119	95·2	246·2
214	171·2	417·2	166	132·8	330·8	118	94·4	244·4
213	170·4	415·4	165	132	329	117	93·6	242·6
212	169·6	413·6	164	131·2	327·2	116	92·8	240·8
211	168·8	411·8	163	130·4	325·4	115	92	239
210	168	410	162	129·6	323·6	114	91·2	237·2
209	167·2	408·2	161	128·8	321·8	113	90·4	235·4
208	166·4	406·4	160	128	320	112	89·6	233·6
207	165·6	404·6	159	127·2	318·2	111	88·8	231·8
206	164·8	402·8	158	126·4	316·4	110	88	230
205	164	401	157	125·6	314·6	109	87·2	228·2
204	163·2	399·2	156	124·8	312·8	108	86·4	226·4
203	162·4	397·4	155	124	311	107	85·6	224·6
202	161·6	395·6	154	123·2	309·2	106	84·8	222·8
201	160·8	393·8	153	122·4	307·4	105	84	221
200	160	392	152	121·6	305·6	104	83·2	219·2
199	159·2	390·2	151	120·8	303·8	103	82·4	217·4
198	158·4	388·4	150	120	302	102	81·6	215·6
197	157·6	386·6	149	119·2	300·2	101	80·8	213·8
196	156·8	384·8	148	118·4	298·4	100	80	212
195	156	383	147	117·6	296·6	99	79·2	210·2
194	155·2	381·2	146	116·8	294·8	98	78·4	208·4
193	154·4	379·4	145	116	293	97	77·6	206·6
192	153·6	377·6	144	115·2	291·2	96	76·8	204·8
191	152·8	375·8	143	114·4	289·4	95	76	203
190	152	374	142	113·6	287·6	94	75·2	201·2
189	151·2	372·2	141	112·8	285·8	93	74·4	199·4

Conversion of the different Thermometric Scales.

Table II.—*continued.*

Cent.	Reaum.	Fahr.	Cent.	Reaum.	Fahr.	Cent.	Reaum.	Fahr.
92	73·6	197·6	49	39·2	120·2	6	4·8	42·8
91	72·8	195·8	48	38·4	118·4	5	4	41
90	72	194	47	37·6	116·6	4	3·2	39·2
89	71·2	192·2	46	36·8	114·8	3	2·4	37·4
88	70·4	190·4	45	36	113	2	1·6	35·6
87	69·6	188·6	44	35·2	111·2	1	0·8	33·8
86	68·8	186·8	43	34·4	109·4	0	0	32
85	68	185	42	33·6	107·6	−1	−0·8	30·2
84	67·2	183·2	41	32·8	105·8	−2	−1·6	28·4
83	66·4	181·4	40	32	104	−3	−2·4	26·6
82	65·6	179·6	39	31·2	102·2	−4	−3·2	24·8
81	64·8	177·8	38	30·4	100·4	−5	−4	23
80	64	176	37	29·6	98·6	−6	−4·8	21·2
79	63·2	174·2	36	28·8	96·8	−7	−5·6	19·4
78	62·4	172·4	35	28	95	−8	−6·4	17·6
77	61·6	170·6	34	27·2	93·2	−9	−7·2	15·8
76	60·8	168·8	33	26·4	91·4	−10	−8	14
75	60	167	32	25·6	89·6	−11	−8·8	12·2
74	59·2	165·2	31	24·8	87·8	−12	−9·6	10·4
73	58·4	163·4	30	24	86	−13	−10·4	8·6
72	57·6	161·6	29	23·2	84·2	−14	−11·2	6·8
71	56·8	159·8	28	22·4	82·4	−15	−12	5
70	56	158	27	21·6	80·6	−16	−12·8	3·2
69	55·2	156·2	26	20·8	78·8	−17	−13·6	1·4
68	54·4	154·4	25	20	77	−18	−14·4	−0·4
67	53·6	152·6	24	19·2	75·2	−19	−15·2	−2·2
66	52·8	150·8	23	18·4	73·4	−20	−16	−4
65	52	149	22	17·6	71·6	−21	−16·8	−5·8
64	51·2	147·2	21	16·8	69·8	−22	−17·6	−7·6
63	50·4	145·4	20	16	68	−23	−18·4	−9·4
62	49·6	143·6	19	15·2	66·2	−24	−19·2	−11·2
61	48·8	141·8	18	14·4	64·4	−25	−20	−13
60	48	140	17	13·6	62·6	−26	−20·8	−14·8
59	47·2	138·2	16	12·8	60·8	−27	−21·6	−16·6
58	46·4	136·4	15	12	59	−28	−22·4	−18·4
57	45·6	134·6	14	11·2	57·2	−29	−23·2	−20·2
56	44·8	132·8	13	10·4	55·4	−30	−24	−22
55	44	131	12	9·6	53·6	−31	−24·8	−23·8
54	43·2	129·2	11	8·8	51·8	−32	−25·6	−25·6
53	42·4	127·4	10	8	50	−33	−26·4	−27·4
52	41·6	125·6	9	7·2	48·2	−34	−27·2	−29·2
51	40·8	123·8	8	6·4	46·4	−35	−28	−31
50	40	122	7	5·6	44·6			

BUTTER ANALYSIS.

5 Grams Butter Fat being taken for Saponification.

c.c. $\frac{N}{2}$ acid used (1 c.c. = ·028 gram KHO.).	Grams of KHO required for 1000 grams of Fat.	Saponification Equivalent.*	°/₀ Margarine.†
	+ ·1 c.c. = + 0·6		+ ·1 c.c. = − 1·8
34·9	195·4	286·5	100·
35·0	196·0	285·7	98·3
·2	197·1	284·1	94·8
·4	198·2	282·5	91·3
·6	199·4	280·9	87·5
·8	200·5	279·3	84·0
36·0	201·6	277·8	80·5
·2	202·7	276·2	77·0
·4	203·8	274·7	73·5
·6	205·0	273·2	69·7
·8	206·1	271·7	66·3
37·0	207·2	270·3	62·8
·2	208·3	268·8	59·3
·4	209·4	267·4	55·8
·6	210·6	265·9	52·0
·8	211·7	264·5	48·5
38·0	212·8	263·2	45·0
·2	213·9	261·8	41·5
·4	215·0	260·5	38·0
·6	216·2	259·0	34·2
·8	217·3	257·7	30·7
39·0	218·4	256·4	27·3
·2	219·5	255·1	23·8
·4	220·6	253·9	20·3
·6	221·8	252·5	16·5
·8	222·9	251·2	13·0
40·0	224·0	250·0	9·5
·2	225·1	248·8	6·0
·4	226·2	247·6	2·5
·6	227·4	246·8	...
·8	228·5	245·1	...
41·0	229·6	243·9	...
·2	230·7	242·7	...
·4	231·8	241·6	...
·6	233·0	240·3	...

* That is, the number of grams of fat that would be saponified by 1 litre of a normal solution of *any* alkali. It is the quotient obtained by dividing 56000 by "grams of KHO required by 1000 grams of fat."

† The figures given in this column are useful *approximate* values, calculated from Koettstorfer's formula, $x = 3{\cdot}17\ (227 - n)$, where x = percentage of margarine sought, and n = number of grams of KHO required for 1000 grams of fat. According to Koettstorfer n may lie between 232·4 and 221·5 for butter, the mean being 227, whilst for margarine the value may be taken to be 195·5.

Butter Analysis.

5 Grams Butter Fat being taken.

$\frac{N}{10}$ c.c. Alkali.	% Soluble or Volatile Acids.*	$\frac{N}{10}$ c.c. Alkali.	% Soluble or Volatile Acids.	$\frac{N}{10}$ c.c. Alkali.	% Soluble or Volatile Acids.
1·0	0·18	13·5	2·38	26·0	4·58
1·5	0·26	14·0	2·46	26·5	4·66
2·0	0·35	14·5	2·55	27·0	4·75
2·5	0·44	15·0	2·64	27·5	4·84
3·0	0·53	15·5	2·73	28·0	4·93
3·5	0·62	16·0	2·82	28·5	5·02
4·0	0·70	16·5	2·90	29·0	5·10
4·5	0·79	17·0	2·99	29·5	5·19
5·0	0·88	17·5	3·08	30·0	5·28
5·5	0·97	18·0	3·17	30·5	5·37
6·0	1·06	18·5	3·26	31·0	5·46
6·5	1·14	19·0	3·34	31·5	5·54
7·0	1·23	19·5	3·43	32·0	5·63
7·5	1·32	20·0	3·52	32·5	5·72
8·0	1·41	20·5	3·61	33·0	5·81
8·5	1·50	21·0	3·70	33·5	5·90
9·0	1·58	21·5	3·78	34·0	5·98
9·5	1·67	22·0	3·87	34·5	6·07
10·0	1·76	22·5	3·96	35·0	6·16
10·5	1·85	23·0	4-05		
11·0	1·94	23·5	4·14	0·1	0·02
11·5	2·02	24·0	4·22	0·2	0·04
12·0	2·11	24·5	4·31	0·3	0·05
12·5	2·20	25·0	4·40	0·4	0·07
13·0	2·29	25·5	4·49		

* Calculated as Butyric Acid, $C_4H_8O_2=88$.

Milk Analysis.

Table to find the sp. gr. of Milk at 60° Fah. from its sp. gr. at any Temperature between 50° and 70° Fah. (water=1000).

° Fah.	1020	1021	1022	1023	1024	1025	1026	1027	1028	1029	1030	1031	1032	1033	1034	1035
50	19·2	20·2	21·2	22·2	23·2	24·1	25·1	26·1	27·0	28·0	29·0	29·9	30·9	31·8	32·7	33·6
51	·3	·3	·3	·3	·3	·2	·2	·2	·1	·1	·1	30·0	31·0	·9	·9	·8
52	·4	·3	·3	·3	·3	·3	·2	·2	·2	·2	·1	·1	·1	32·0	33·0	·9
53	·4	·4	·4	·4	·4	·4	·3	·3	·3	·3	·2	·2	·2	·1	·1	34·0
54	·5	·5	·5	·5	·5	·5	·4	·4	·4	·4	·3	·3	·3	·3	·2	·2
55	·6	·6	·6	·6	·6	·6	·5	·5	·5	·5	·4	·4	·4	·4	·3	·3
56	·7	·7	·7	·7	·6	·6	·6	·6	·6	·6	·6	·5	·5	·5	·5	·5
57	·8	·8	·8	·8	·7	·7	·7	·7	·7	·7	·7	·6	·6	·6	·6	·6
58	·9	·9	·9	·8	·8	·8	·8	·8	·8	·8	·8	·8	·7	·7	·7	·7
59	·9	·9	·9	·9	·9	·9	·9	·9	·9	·9	·9	·9	·9	·9	·9	·9
60	20·0	21·0	22·0	23·0	24·0	25·0	26·0	27·0	28·0	29·0	30·0	31·0	32·0	33·0	34·0	35·0
61	·1	·1	·1	·1	·1	·1	·1	·1	·1	·1	·1	·2	·2	·2	·2	·2
62	·2	·2	·2	·2	·2	·2	·2	·3	·3	·3	·3	·3	·3	·3	·3	·3
63	·2	·3	·3	·3	·3	·3	·3	·4	·4	·4	·4	·4	·5	·5	·5	·5
64	·3	·4	·4	·4	·4	·4	·5	·5	·5	·5	·5	·5	·6	·6	·6	·6
65	·4	·5	·5	·5	·5	·5	·6	·6	·6	·6	·7	·7	·7	·8	·8	·8
66	·5	·6	·6	·6	·6	·6	·7	·7	·7	·8	·8	·8	·9	·9	·9	·9
67	·6	·7	·7	·7	·7	·7	·8	·8	·8	·9	·9	32·0	33·0	34·0	35·0	36·1
68	·7	·8	·8	·8	·9	·9	27·0	28·0	29·0	30·1	31·1	·2	·2	·2	·2	·2
69	·9	22·0	23·0	24·0	25·0	26·0	·1	·1	·1	·2	·2	·2	·3	·3	·3	·4
70	21·0	·1	·1	·1	·1	·1	·2	·2	·2	·3	·3	·4	·4	·5	·5	·5

The observed sp. gr. is given at the top of each column, and the number in the column opposite to the temperature at which the sp. gr. was determined added to 1000 gives the sp. gr. at 60° F.

Ex. 1. Milk of which the sp. gr. is 1032 at 54° F. is 1031·3 at 60° F.

Ex. 2. Milk of which the sp. gr. is 1028·6 at 63° F. becomes 1000 + (28·4 + 0·6) = 1029 at 60° F.

TABLE OF RECIPROCALS.

No.	Reciprocal.	No.	Reciprocal.	No.	Reciprocal.	No.	Reciprocal.
1	1	31	·03226	61	·01639	91	·01099
2	·5	32	·03125	62	·01613	92	·01087
3	·33333	33	·03030	63	·01587	93	·01075
4	·25	34	·02941	64	·01563	94	·01064
5	·2	35	·02857	65	·01539	95	·01053
6	·16667	36	·02778	66	·01515	96	·01042
7	·14286	37	·02703	67	·01493	97	·01031
8	·125	38	·02632	68	·01471	98	·01020
9	·11111	39	·02564	69	·01449	99	·01010
10	·1	40	·025	70	·01429	100	·01
11	·09091	41	·02439	71	·01409	101	·00990
12	·08333	42	·02381	72	·01389	102	·00980
13	·07692	43	·02326	73	·01370	103	·00971
14	·07143	44	·02273	74	·01351	104	·00962
15	·06667	45	·02222	75	·01333	105	·00952
16	·0625	46	·02174	76	·01316	106	·00943
17	·05882	47	·02128	77	·01299	107	·00935
18	·05556	48	·02083	78	·01282	108	·00926
19	·05263	49	·02041	79	·01266	109	·00917
20	·05	50	·02	80	·0125	110	·00909
21	·04762	51	·01961	81	·01235	111	·00901
22	·04545	52	·01923	82	·01220	112	·00893
23	·04348	53	·01887	83	·01205	113	·00885
24	·04167	54	·01852	84	·01191	114	·00877
25	·04	55	·01818	85	·01177	115	·00870
26	·03846	56	·01786	86	·01163	116	·00862
27	·03704	57	·01754	87	·01149	117	·00855
28	·03571	58	·01724	88	·01136	118	·00847
29	·03448	59	·01695	89	·01124	119	·00840
30	·03333	60	·01667	90	·01111	120	·00833

Ex. 1. $\frac{100}{17} \times \cdot 01 = \frac{1}{17} = 0 \cdot 05882.$

Ex. 2. $\frac{100}{43} \times \cdot 02 = \frac{1}{43} \times 2 = \cdot 02326 \times 2 = 0 \cdot 04652.$

Ex. 3. $\frac{100}{82} \times \cdot 005 = \frac{1}{82} \times \frac{1}{2} = \frac{0 \cdot 0122}{2} = 0 \cdot 0061.$

Glycerine Table.

Per cent. Glycerine.	Sp. gr. $\frac{15^\circ \text{ C.}}{15^\circ} = \frac{59^\circ \text{ F.}}{59^\circ}$	Sp. gr. $\frac{20^\circ \text{ C.}}{20^\circ} = \frac{68^\circ \text{ F.}}{68^\circ}$	Per cent. Glycerine.	Sp. gr. $\frac{15^\circ \text{ C.}}{15^\circ}$.	Per cent. Glycerine.	Sp. gr. $\frac{15^\circ \text{ C.}}{15^\circ}$.
100	1·26596	1·26348	74	1·19583	40	1·10253
99	1·26335	1·26085	73	1·19309	35	1·08908
98	1·26072	1·25822	72	1·19035	30	1·07564
97	1·25809	1·25560	71	1·18761	25	1·06236
96	1·25547	1·25297	70	1·18487	20	1·04930
95	1·25285	1·25034	69	1·18212	15	1·03652
94	1·25021	1·24771	68	1·17937	10	1·02409
93	1·24756	1·24508	67	1·17662	5	1·01189
92	1·24487	1·24246	66	1·17387		
91	1·24217	1·23983	65	1·17113		
90	1·23945	1·23720	64	1·16837		
89	1·23673	1·23449	63	1·16561		Sp. gr. $\frac{20^\circ \text{ C.}}{20^\circ}$
88	1·23400	1·23178	62	1·16286		
87	1·23128	1·22907	61	1·16011		
86	1·22855	1·22636	60	1·15737		
85	1·22583	1·22365	59	1·15462		
84	1·22310	1·22094	58	1·15187		
83	1·22038	1·21823	57	1·14912	70	1·18293
82	1·21766	1·21552	56	1·14637	60	1·15561
81	1·21493	1·21281	55	1·14362	50	1·12831
80	1·21221	1·21010	54	1·14088	40	1·10118
79	1·20949	1·20737	53	1·13814	30	1·07469
78	1·20677	1·20464	52	1·13539	20	1·04884
77	1·20404	1·20190	51	1·13265	10	1·02391
76	1·20131	1·19917	50	1·12990		
75	1·19857	1·19644	45	1·11618		

The above table is a combination of W. W. J. Nicol's excellent tables for the two temperatures above specified, as given in the *United States Dispensatory*, p. 653, and in Watts's *Dictionary of Chemistry* (most recent edition in each case). In the former work a complete table from 1–100°/$_\circ$ glycerine, at 15° C. is given.

The following formula is useful :—

$$\frac{\text{sp. gr. of dilute glycerine}—1·000}{·002665} = °/_\circ \text{ by weight of glycerine.}$$

The divisor ·00261 is more accurate, however, for mixtures containing between 30 and 60°/$_\circ$ glycerine, and ·0025 for those below 30°/$_\circ$.

Temperature ° C.	For use in Calibrating Instruments.		For use with Standard Solutions.	
	Weight of 1 Litre of Water.	Volume of 1 Gram of Water.	Volume corresponding with 1 Litre at 15° C.	Volume of 1 c.c. reduced to 15° C.
	grams.	c.c.	c.c.	c.c.
5	998·6	1·0014	998·3	1·0017
6	,,	,,	·4	1·0016
7	,,	,,	·5	1·0014
8	,,	,,	·7	1·0013
9	,,	,,	·9	1·0011
10	998·5	1·0015	999·0	1·0010
11	,,	,,	·2	1·0008
12	998·4	1·0016	·4	1·0006
13	·3	1·0017	·6	1·0004
14	·2	1·0018	·8	1·0002
15	·1	1·0019	1000·0	1·0000
16	997·9	1·0021	·2	0·9998
17	·8	1·0022	·4	0·9996
18	·7	1·0023	·6	0·9994
19	·5	1·0025	·8	0·9992
20	·3	1·0027	1001·1	0·9989
21	·2	1·0028	·3	0·9987
22	997·0	1·0030	·6	0·9984
23	996·8	1·0032	·8	0·9982
24	·6	1·0034	1002·0	0·9980
25	·3	1·0037	·3	0·9977

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